Report No. CG-D-14-95

Technical Evaluation of the CG-47201 6V-92 Detroit Diesel Electronic Control (DDEC) Propulsion Modification

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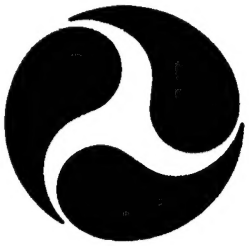

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16. Abstract

This report describes the testing and evaluation (T&E) of the CG-47201 6V-92 DDEC Propulsion Modification that was conducted at Coast Guard Station Cape May, New Jersey, during the period 8-12 November 1994.

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METRIC CONVERSION FACTORS

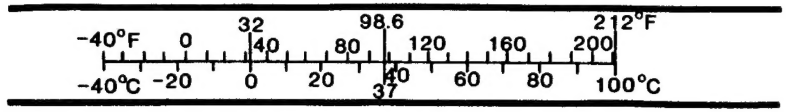
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	* 2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (WEIGHT)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (EXACT)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly).

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (WEIGHT)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	0.125	cups	c
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (EXACT)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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Recognition is due to Messrs. Robert Desruisseau and Bert Macesker along with Senior Chief Petty Officer Thomas Brion of the Research and Development Center who instrumented the CG-47201 and collected and reduced a large portion of the data. In addition, their assistance in formatting test results made a significant contribution to the timely preparation of the quick look reports and to the preparation of this report.

As a final acknowledgment, I would like to thank Lieutenant Carl Frank of the Office of Acquisition at Coast Guard Headquarters for assistance in formulating the Test Procedures, his assistance during the tests, and his valuable comments in formatting the test results.

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TABLE OF CONTENTS

TABLE OF CONTENTS

FIGURES

TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

AC&I	Acquisition, Construction, and Improvements
AP	Aft Perpendicular
BHP	Brake Horsepower
CFM	Cubic Feet per Minute
CTP	Critical Technical Parameters
D	Diameter
DDEC	Detroit Diesel Electronic Control
deg F	Degrees Fahrenheit
DEMP	Diesel Engine Maintenance Performance
Displ	Displacement
DT&E	Developmental Testing and Evaluation
ERPM	Engine Revolutions Per Minute
FC	Fuel Consumption
FT	Feet
FWD	Forward
GPH	Gallons Per Hour
GPS	Global Positioning System
ISO	International Standards Organization
lbs	Pounds
LBP	Length Between Perpendiculars
LCG	Longitudinal Center of Gravity
LOP	Lubricating Oil Pressure
LT	Long Tons (2240 pounds)
lvr	Louver
max	Maximum
ml	milliliter
MLB	Motor Lifeboat
NM	Nautical Miles
ORD	Operational Requirements Document
OT&E	Operational Testing and Evaluation
P	Pitch
P/D	Pitch to Diameter ratio
ppm	Parts per million
PSIG	Pounds per Square Inch Gauge
R&DC	USCG Research and Development Center
RPM	Revolutions Per Minute
SHP	Shaft Horsepower
SOG	Speed Over Ground
Spd	Speed
SRPM	Shaft Revolutions Per Minute
t	Time (seconds)
T&E	Testing and Evaluation
TACMAN	R&DC developed Tactical and Maneuvering software
TECHEVAL	Technical Evaluation
U/W	Underway
WPB	USCG Patrol Boat
WTD	Watertight Door

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EXECUTIVE SUMMARY

This report describes the testing and evaluation (T&E) of the CG-47201 6V-92 DDEC Propulsion Modification that was conducted at Coast Guard Station Cape May, New Jersey during the period 8 NOVEMBER 1994 through 12 NOVEMBER 1994 by the United States Coast Guard (USCG) Research and Development Center (R&DC).

The T&E established the Detroit Diesel 6V-92 DDEC engines meet the 47-FT Motor Lifeboat (MLB) specification requirements dealing with speed. The DDEC engine does not meet the provided criteria for endurance and range as discussed in Section 4.4 of the report.* (See below)

The 47-FT MLB, CG-47201, DDEC accelerates quicker than the 6V-92TA installed on the CG-47200.

The DDEC installation exceeded the at-sea towing criteria of towing a 110' Patrol Boat (WPB) in calm water at 6 knots with at least 10% reserve power.

Detailed power versus speed curves, for the 47 MLB operating at typical loading conditions and for towing of a 110' WPB were generated.

Engine performance curves for the Port DDEC diesel engine were generated.

* It should be noted that the 6V-92 DDEC engines provided slightly greater range and endurance than the 6V-92 TA engines and both meet the preproduction specification which did not include a 20% fuel reserve. The DDEC engines should satisfy the sponsor's current range and endurance requirements, as approved at Key Decision Point 4 and outlined in the current Operational Requirements Document (ORD).

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1.0 INTRODUCTION

This report provides the results of the Technical Evaluation of the 47-FT MLB, CG-47201, 6V-92 DDEC Propulsion Modification.

1.1 Purpose of the Test

This testing was initiated by a request for Acquisition, Construction, and Improvements (AC&I) support initiated by Commandant (G-AWP). The testing was conducted in response to task elements assigned to R&DC in the Testing and Evaluation (T&E) Plan developed by G-AWP "6-V92 DDEC PROPULSION MODIFICATION TESTING AND EVALUATION PLAN - MOTOR LIFEBOAT REPLACEMENT", reference [1].

1.2 Background

Reference [1] provides the following background:

"One prototype and five preconstruction 47' MLBs were built for the Coast Guard by Textron Marine. These boats all were equipped with Detroit Diesel 6V-92 TA engines, a 2:1 reduction gear and eventually a 28" diameter by 33" pitch propeller. Developmental T&E (DT&E) and initial Operational T&E (OT&E) verified that the propulsion system met all ORD requirements in terms of speed and fuel economy.

However, late in the OT&E two of the six boats' engines began failing prematurely. As of October 1994, five engines had failed between these two boats after 1200-1500 hours service with broken top piston rings, scored cylinder liners, cylinder kit distress, cracked cylinder heads, or a combination of these faults noted. The original maintenance philosophy called for the engines to run 5000 to 6000 hours between failures.

While the exact cause of the failures has not yet been determined, Detroit Diesel has recommended the 6V-92 DDEC engine as the solution. The Coast Guard was already investigating switching to this engine for emissions and fuel economy reasons.

The salient characteristics of this propulsion system are:

a. electronically controlled fuel injection
b. electronically monitored performance
c. an intermittent engine duty rating
d. maximum power of 425 Brake Horsepower (BHP) at 2100 engine revolutions per minute (ERPM)
e. more power developed at less ERPM throughout engine speed range
f. increased pitch propellers

The Coast Guard Yard completed engine changeout to DDEC on 47' MLB, CG-47201 on 26 October 1994."

A testing program was initiated by reference [1]. The R&DC Technical Evaluation (TECHEVAL) was conducted at Coast Guard Station Cape May, New Jersey during the period 8 NOVEMBER through 12 NOVEMBER 1994.

1.3 Objectives of the Test

Primary objectives of the T&E as established by the Test Plan, Reference [1] were:

a. Determine whether or not the Detroit Diesel 6V-92 DDEC engines driving new propellers meet the 47' MLB specification requirements dealing with speed and endurance.

b. Develop detailed power versus speed curves, which identify all humps and hollows, for the 47 MLB operating at typical loading conditions and during towing.

Secondary objectives defined by reference [1] were:

a. Determine whether the following parameters are within the manufacturer's recommended limits during all normal operations and towing operations:

1. engine room inlet pressure/vacuum
2. engine room/ambient air temperature differential
3. exhaust back pressure
4. exhaust temperature
5. raw water pressure
6. jacket water temperature

b. Determine whether the 6V-92 DDEC engine meets current and pending emissions standards.

1.4 Measurements Performed

Table 1.1 lists the tests conducted during the TECHEVAL.

TABLE 1-1
LIST OF TECHEVAL TESTS AND TEST PROCEDURE NUMBERS

TP Number	Test Description
47MLB-RDC-01	PRINCIPAL CHARACTERISTICS
47MLB-RDC-02	CALM WATER POWER VERSUS SPEED
47MLB-RDC-03	THERMOGRAPHY
47MLB-RDC-04	FUEL CONSUMPTION
47MLB-RDC-05	ACCELERATION
47MLB-RDC-06	CRASH STOP/CRASH REVERSAL
47MLB-RDC-07	BOLLARD PULL AND U/W TOWING
47MLB-RDC-10	EMISSIONS

Individual test procedures were developed by R&DC for each test. All testing is considered as calm water in order to allow a comparison to the Builders Sea Trial Data. Section 2 of this report describes each test with a brief discussion.

1.5 Test Equipment

Shaft torque and RPM were measured using a Wireless Data Corp. Horsepower Meter, Model 1642A.

Vessel position and speed were recorded using an ASHTEC Global Positioning System (GPS) Receiver, Model RANGER XII.

A TEAC 16-Channel DAT Digital Tape Recorder, Model RD-200-TPCM, was utilized to record shaft RPM, torque, and horsepower for both shafts (6 channels) with an additional channel used to record audio observations throughout the testing.

The acceleration and deceleration data were collected using the ASHTEC GPS which provided input via an RS-232 port into a COMPAQ Portable 486C/66. The COMPAQ was used to run the R&DC Tactical and Maneuvering (TACMAN) software.

A Tripp Lite 1000 Watt Inverter, Model PV-1000 FC/24V was utilized to obtain 110VAC power for the test equipment.

Boost Pressure (R&DC "Hg) and Exhaust Back Pressure were measured using the Diesel Engine Maintenance Performance (DEMP) analog gauges, Caterpillar P/N 1U5470 (NSN 4910-01-136-1058).

Fuel was measured by using a 3000 milliliter (ml) graduated cylinder installed in line with the port engine and timing the period for the level to drop.

The DDEC "Pro-Link 9000" Data Link used by Detroit Diesel personnel for portions of the testing provided on-demand snapshots of ERPM, Throttle Set RPM, Engine Load Percentage, Coolant Temperature, Oil Pressure, Engine Oil Temperature, Boost Pressure (DDEC-psig), Barometric Pressure, and Fuel Consumption. It should be noted that the Engine Load Percentage and Fuel Consumption data are tabular data contained within the DDEC software while the other data listed above represent actual sensor measurements.

A Shortridge Instruments, Inc. Air Flow Meter, Model ADM870 measured air flow-uncorrected, air flow-corrected, air inlet air temperature, and air inlet pressure.

A Enerac 2000E Portable Emissions Analyzer was utilized to collect the emissions data.

An Astro-Med, Inc. Strip Chart Recorder was used to post-process the Deceleration.

Trimetrix, Inc. Axum Plotting Routines, Version 3.0 was used to generate the graphs contained in this report.

2.0 TEST PROCEDURES

The following test procedures were generated based on the requirements stipulated within reference [1] and using the testing methodologies outlined in references [2] - [4].

2.1 Principal Characteristics

This test provides physical descriptive information comparing the 47' MLB with the 6V-92 DDEC engine to the 47' MLB with the 6V-92 TA that was used in the original DT&E and acceptance trials. With the exception of the engine and propeller, every effort was made to limit the differences between this boat and the boat used in the original DT&E. This test was to determine if the boat meets the following Critical Technical Parameters (CTPs) and Thresholds:

(1) Draft - 4'6"
(2) Displacement:
  Hoisting Weight - (Light Ship + outfit + 95% fuel + 0 people) - 39742 pounds
  Trial Condition - (Light Ship + outfit + 50% fuel + 9 people) - 39872 pounds
  Maximum Load Condition - 42,355 pounds
(3) Longitudinal Center of Gravity (LCG) for Trial Weight - 16.5 feet forward (fwd) of Aft Perpendicular (AP)
(4) Maximum Speed (max) - $\geq$ 25 knots
(5) Idle Speed - $\leq$6.0 knots

2.2 Calm Water Power versus Speed

This test compares the power versus speed characteristics of the 6V-92 DDEC engine to the 47' MLB with the 6V-92 TA and the Sponsor Requirements. The shaft horsepower (SHP) was measured throughout the speed range and humps and hollows in the power-speed curve identified. The power-speed performance was determined by making runs at various ERPM. These runs were conducted at 550, 750, 1000, 1200, 1400, 1600, 1800, 1950 and 2100 ERPM representing the range from engine idle speed up to full power. The tests were conducted for two displacements. The target displacements in both pounds (lbs) and long tons (LT) and longitudinal centers of gravity (LCG) were determined based on the trials displacement (Displ) for Preliminary Acceptance Trials for 47201 and the maximum load condition used for the 47200 TECHEVAL documented by reference [5].

Displ (lbs)	Displ (LT)	LCG (Ft fwd AP)	LCG (% LBP)
39,872	17.80	16.5	38.4
42,355	18.91	17.37	40.4

This test was to determine if the boat meets the following Critical Technical Parameters (CTPs) and Thresholds:

(1) Maximum Speed - $\geq$ 25 Knots
(2) Idle Speed - $\leq$ 6.0 knots

2.3 Thermography

This test was to use thermal imaging to measure overall engine load as indicated by block and head temperatures. Similar tests on a non-DDEC 47-FT MLB could provide a baseline for comparison.

2.4 Fuel Consumption

This test compares the fuel consumption versus speed characteristics of the 6V-92 DDEC to the 6V-92 TA and the Sponsor Requirements. This test was to determine if the boat meets the following thresholds with a 20% fuel reserve:

(1) Range at Maximum Speed - 200 NM
(2) Endurance at Maximum Speed - 8 hours

2.5 Acceleration

This test compares the acceleration characteristics of the 6V-92 DDEC propulsion plant to the 6V-92 TA.

2.6 Crash Stop/Crash Reversal

This test compares the deceleration characteristics of the 6V-92 DDEC propulsion plant to the 6V-92 TA.

2.7 Bollard Pull and U/W Towing

This test determined the towline pull of the boat in a bollard pull (static) condition and compares the bollard pull characteristics of the 6V-92 DDEC propulsion plant to the 6V-92 TA. This test was to determine if the boat could provide 9,500 lbs bollard pull with at least 10% reserve power.

The second phase of this test determined the towline pull of the boat in an at-sea towing condition and compared the underway towing characteristics of the 6V-92 DDEC propulsion plant to the 6V-92 TA. This test was to determine if the boat can tow a 110' WPB in calm water at 6 knots with at least 10% reserve power and to provide a qualitative assessment of the maneuverability during towing.

2.8 Emissions

A test protocol following the format of ISO 8178 was used and will be discussed in a separate R&DC report. These emissions measurements were taken for a separate project that utilized this

opportunity of the 47-FT MLB instrumented for the DDEC Tests.

3.0 TEST RESULTS

Due to the large number of figures, only three (SHP versus Speed, Engine RPM (ERPM) versus Speed, and Fuel Consumption versus Speed) are presented within the body of this report. Appendix A contains figures related to the test procedures. Appendix B contains tables and figures related to engine performance under the various test procedures performed.

3.1 Principal Characteristics

CG-47201 was weighed on 8 NOVEMBER using four force transducers. The condition of the boat consisted of:

No crew on board
Fuel Tank - 375 gallons by sounding stick

The weighing on 8 NOV was 40,589 pounds which included R&DC test equipment (344 lbs). This weight was then used as a baseline in determining the displacement and LCG of the boat for the other tests conducted with loads adjusted for variables such as fuel, personnel, and additional test equipment as appropriate. Accounting for the test equipment and fuel yields a calculated hoisting weight of 40,350 lbs. The load cells are accurate to ± 1%. The longitudinal center of gravity was calculated at 16.5 FT forward of the aft perpendicular. Table 3-1 provides the target and actual hoisting weight.

TABLE 3-1
TARGET AND ACTUAL HOISTING WEIGHT

	Displ (lbs)	Displ (LT)	LCG (Ft fwd AP)	LCG (% LBP)
Target Hoisting	39,742	17.74	16.5	38.4
Actual Hoisting	40,350	17.97	16.5	38.4

3.2 Calm Water Power versus Speed

Calm water power versus speed was conducted on 10 and 11 NOVEMBER 1994 at two displacements, trials and maximum weight. Table 3-2 provides target and actual displacements and longitudinal centers of gravity. It should be noted that to account for the R&DC Test Equipment the 900-FT 3-1/4 inch and 300-FT 2 inch towing hawsers were removed from the boat for the "trials displacement". Typically the trials were conducted at maximum power first and continued in decreasing RPM increments. Table 3-5 in section 3.4, FUEL CONSUMPTION includes the SHP measured at each RPM interval. Graphs depicting the performance for the starting displacements of 40,218 and 42,320 pounds for

SHP versus Speed and ERPM versus Speed are Figures 3-1 and 3-2 respectively. It should be noted that as fuel was consumed during the trial test the lower speed/ERPM tests are actually at lower displacements.

TABLE 3-2
TARGET AND ACTUAL SPEED-POWER DISPLACEMENTS

	Displ (lbs)	Displ (LT)	LCG (Ft fwd AP)	LCG (% LBP)
Target Trials	39,872	17.80	16.5	38.4
Actual Trials	40,218	17.95	16.51	38.4
Target Maximum	42,355	18.91	17.37	40.4
Actual Maximum	42,320	18.89	16.46	38.4

In addition to the two test displacements, two other measurements of speed at full power and 2100 ERPM, were taken. One at the conclusion of the testing at the trials displacement at a displacement of 39,741. The second was conducted after emissions testing on 12 NOVEMBER at a displacement of 39,919.

For Full Power and 2100 ERPM Table 3-3 summarizes the measurements for speed (Spd) and total Shaft Horsepower (SHP) at all four displacements:

TABLE 3-3
SPEED AND TOTAL SHP FOR MAX/2100 ERPM

Displ	Max Spd	ERPM	SHP	Spd @ 2100	ERPM	SHP
39,741	25.8	2183	837	24.5	2105	779
39,919	25.5	2128	788	25.2	2107	777
40,218	26.2	2178	835	24.9	2106	774
42,320	24.6	2128	834	24.1	2103	806

For slow speed operations TABLE 3-4 summarizes the results obtained for Low Idle (550 ERPM) and High Idle (750 ERPM):

TABLE 3-4
SPEED AND TOTAL SHP FOR 550/750 ERPM

Displ	Low Idle Spd	ERPM	SHP	High Idle Spd	ERPM	SHP
40,218	5.2	550	13	7.6	750	49
42,320	5.2	550	14	7.6	750	52

3.3 Thermography

Thermography measurements were initially scheduled for two days including the towing evolution conducted on WEDNESDAY 9

NOVEMBER and then for the first day of Power-Speed trials. Thermography measurements during the towing evolution were discontinued when the thermographer was unable to continue due to the sea conditions. The thermography was terminated due to the weather forecast which called for increasing seas. The front subsequently stalled and the sea conditions for the trials actually improved for the remaining portions of the TECHEVAL.

3.4 Fuel Consumption

Fuel Consumption (FC) for the 47201 DDEC was determined during the Speed-Power trials conducted at the Trials Displacement (40,218 lbs) on THURSDAY 10 NOV 94 and the Maximum Displacement (42,320 lbs) on FRIDAY 11 NOV 94. Fuel flow in gallons per hour (GPH) was measured using a 3000 ml graduated cylinder installed in line with the port engine. Two three-way valves allowed selection of either the boat's installed fuel tank or the graduated cylinder for fuel suction and return. Fuel flow for the port engine in gallons per hour (GPH) was determined by measuring the time (t) in seconds for fuel in milliliters (ml) to be consumed by taking both suction and return from the graduated cylinder and using the relationship:

$$FC\ (GPH) = ml/t \times .951$$

Table 3-5, PREDICTED FUEL CONSUMPTION, represents the fuel consumption for the port engine multiplied by two to obtain a predicted fuel consumption for both engines with the total Shaft Horsepower (SHP) for each RPM interval measured.

TABLE 3-5
PREDICTED FUEL CONSUMPTION

	TRIALS DISPL- 40,218 LBS			MAX DISPL - 42,320 LBS		
ERPM	SHP	SPEED	FC(GPH)	SHP	SPEED	FC(GPH)
2150+	835	26.2	50.0	833	24.8	49.6
2100	774	24.9	47.8	807	24.2	47.8
1950	665	22.6	39.8	705	21.8	40.2
1800	567	19.6	32.6	597	18.8	34.0
1600	447	16.3	25.6	455	14.9	26.2
1400	321	12.2	19.4	326	11.7	19.8
1200	208	10.8	13.4	210	10.7	13.2
1000	109	9.6	8.2	110	9.5	8.2
750	49	7.6	4.8	52	7.6	4.6
550	14	5.2	2.6	13	5.2	2.8

DDEC fuel consumption readings were typically 23.8 GPH per engine at maximum power and 23.2 GPH per engine at 2100 ERPM for the heavier displacement (42,320 pounds). The differences between R&DC and DDEC measurements are considered within the bounds of the errors of the testing methodology.

Figure 3-3 is a graph of Fuel Consumption versus Speed. Figures A-1 and A-2 are graphs of Speed/Fuel Consumption versus ERPM for the trials and maximum displacement respectively.

3.5 Acceleration

Because of the forecasted weather front, measurement of the accelerations was performed during the evening of THURSDAY 10 NOVEMBER at a displacement of 40,179 pounds.

Figure A-3 is a graph of 47201 DDEC T&E Acceleration Data, Speed versus Time, for five acceleration runs.

Figure A-4 is a graph of 47201 DDEC T&E Average Acceleration Data, Speed versus Time. In addition, the graph depicts the 47200 DT&E Acceleration documented in reference [5], "Technical Characteristics Verification of the Prototype 47 FT MLB".

3.6 Crash Stop/Crash Reversal

Because of the forecasted weather front, crash stops were performed during the evening of THURSDAY 10 NOVEMBER at a displacement of 40,179 pounds.

Figure A-5 is a graph of 47201 DDEC T&E Crash Stop Data, Speed versus Time, for six Crash Stops.

3.7 Bollard Pull and U/W Towing

The Bollard Pull was conducted on SATURDAY 12 NOVEMBER. Figure A-6 is the 47201 DDEC Bollard Pull Test Pull versus ERPM. Figure A-7 is Pull versus ERPM for both 47201 and the bollard pull of 47200 documented in reference [5]. Figure A-8 is Bollard Pull versus Bollard Torque.

A maximum pull of 8,200 pounds at 1330/1370 ERPM for the port and starboard shafts respectively was achieved.

It should be noted that the 9,500 pounds pull at 1600 ERPM achieved during testing of 47200 as discussed in reference [5], was achieved using a propeller (prop) with a lower Pitch (P) to Diameter ratio (D), (P/D). A summary of both Bollard Pull results is provided below in TABLE 3-6.

TABLE 3-6
BOLLARD PULL FOR 47200 AND 47201

Boat #	Pull (lbs)	Prop Dia (D)	Prop Pitch (P)	P/D
47200	9,500	28	33	1.18
47201	8,200	28	36	1.29

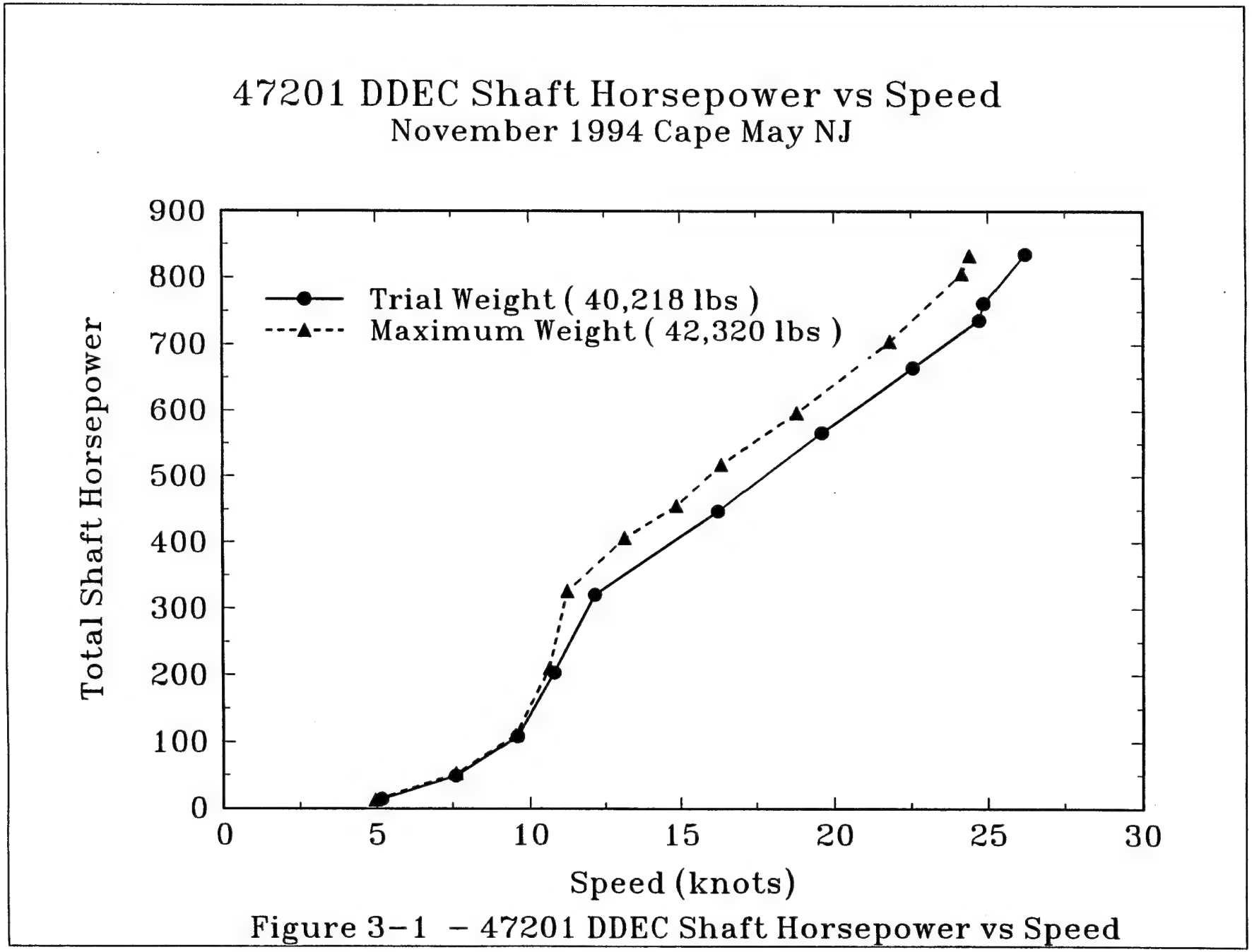

Figure 3–1 – 47201 DDEC Shaft Horsepower vs Speed

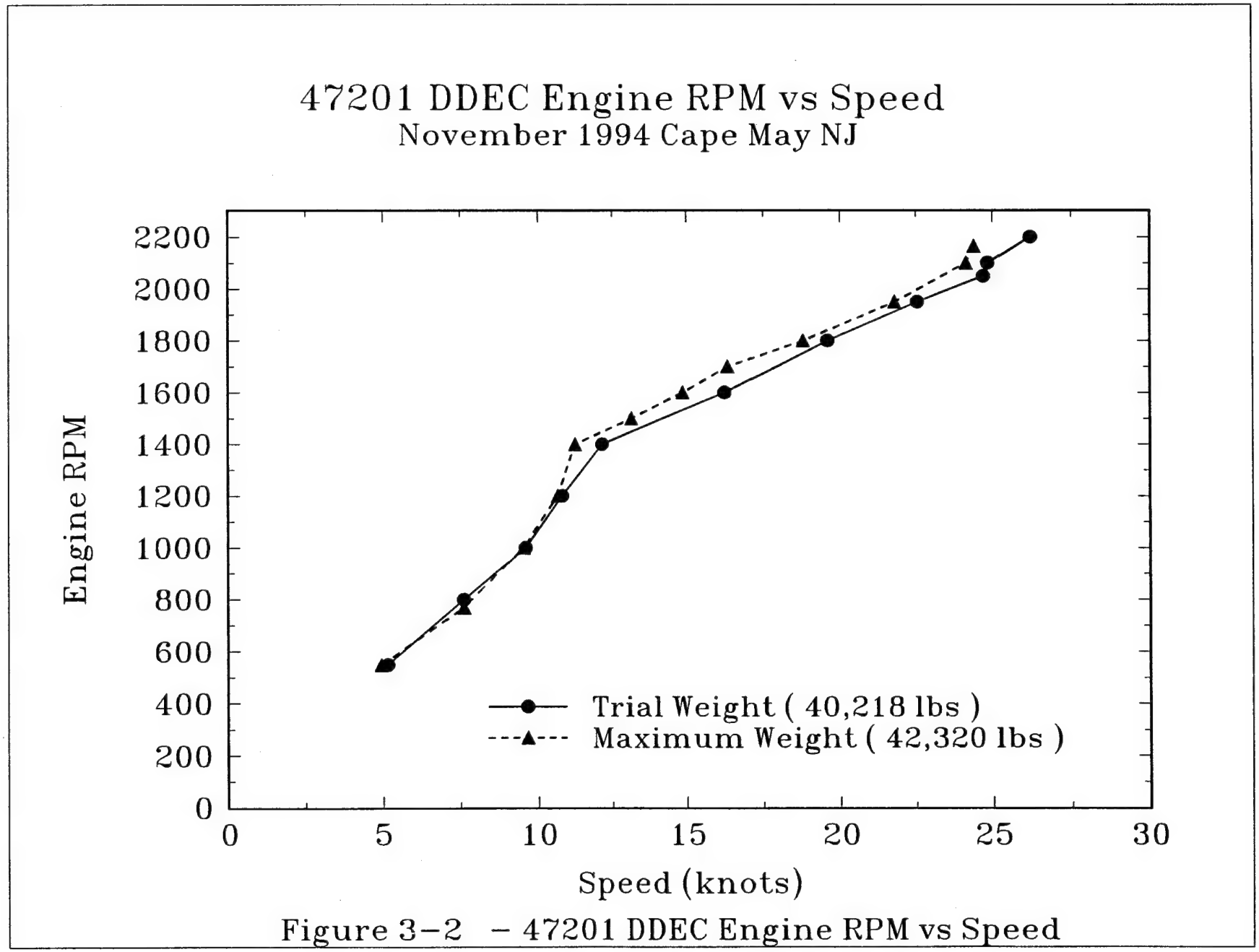

Figure 3–2 – 47201 DDEC Engine RPM vs Speed

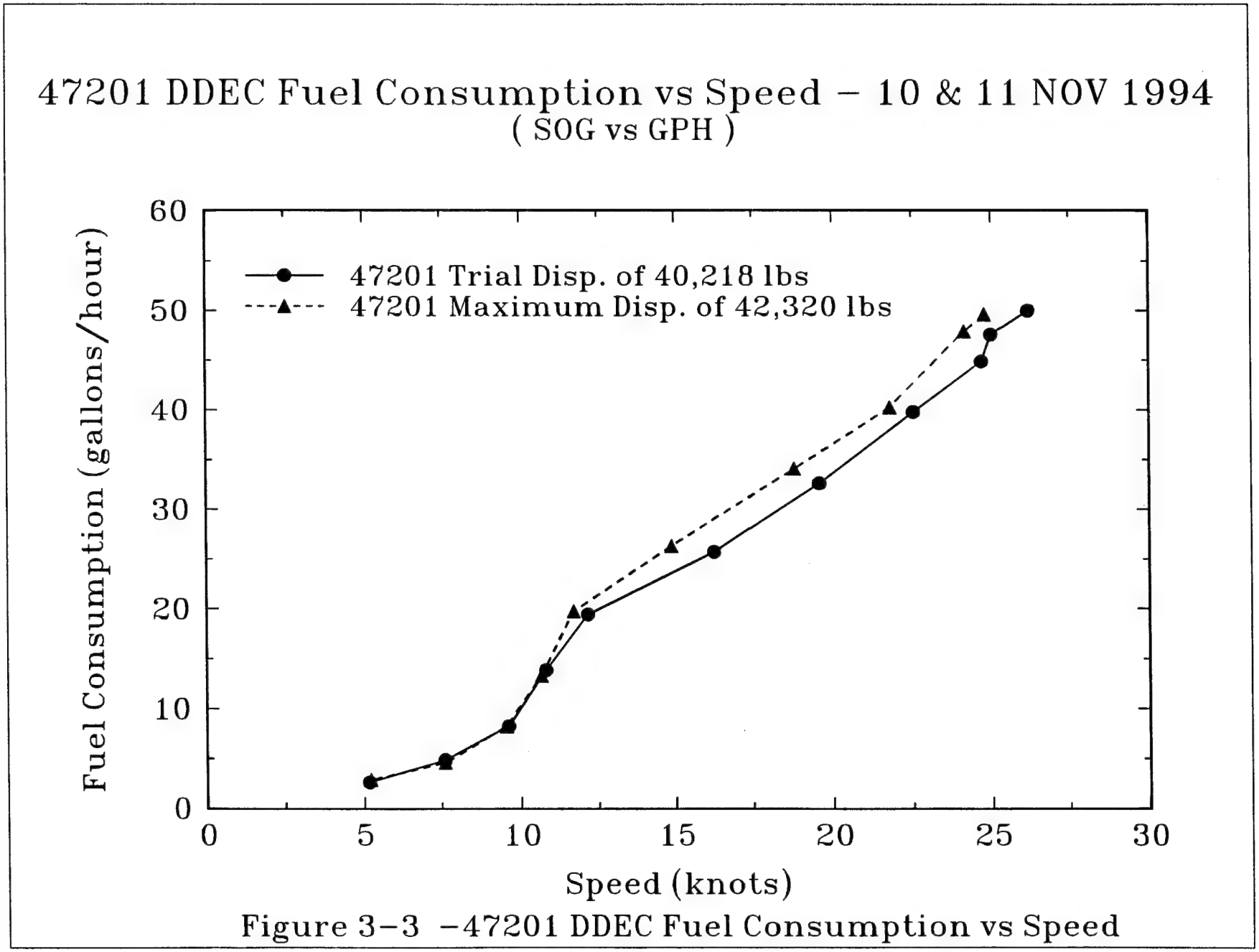

Figure 3–3 –47201 DDEC Fuel Consumption vs Speed

Due to operational requirements the U/W towing was conducted prior to the Bollard Pull on WEDNESDAY 9 NOVEMBER. The U/W towing was conducted with the USCGC AQUIDNECK (WPB 1309) in tow at a displacement of 154 LT based on the ship's Damage Control Nomograph using draft marks of 6'4" forward and 6'6" aft. Freeboards were not taken due to time constraints. Both shafts of the towed vessel were freewheeling and seas were estimated at 2-3 feet. A towing speed of 8.7 knots at 599 SHP and 1564 ERPM into the sea was achieved. The reciprocal course with a following sea achieved a towing speed of 9.2 knots at 579 SHP and 1530 ERPM. A maximum reading of 6,600 pounds pull on the towing hawser with the following sea was noted. Maneuverability during the tow was considered adequate.

Figure A-9 is a graph of the 47201 DDEC Tow Test for Pull versus ERPM. Figure A-10 is a graph of the 47201 DDEC Tow Test for SHP and Speed Over Ground (SOG) versus ERPM.

3.8 Emissions

Emissions data were gathered on the port engine during the towing test conducted on WEDNESDAY 9 NOV 1994, the maximum displacement trials conducted on FRIDAY 11 NOV 1994, and during independent emissions tests conducted at 750, 1200, and 1800 ERPM on 11-12 NOV 1994. These data will be presented in a separate R&DC report on the DDEC emissions.

In addition, emissions data were gathered on the port engine SATURDAY 12 NOV 1994 at 2100 ERPM under a series of five (5) conditions to evaluate the effect of varying degrees of inlet air flow restriction on emissions parameters. This testing was performed to determine if there were any trends in emissions parameters as engine compartment vacuum increased. It should be noted that in order to gather the data for this test the probe connections were run through the engine compartment water tight door (WTD) and then sealed with duct tape since problems were encountered in using the Multi Cable Transit. The manometer reading achieved with the "Door Closed" was 0.6 inches of water as compared to a "normal" reading of 0.7 inches at 2100 ERPM. The data are displayed in Table 3-7, EMISSIONS DATA - 2100 ERPM RESTRICTING AIR INLET, in order of increased manometer readings. Typically three readings were taken and averaged. Trends are indicated in alternate ribbon text. A range of 0 - 0.8 inches of water vacuum was obtained under the below operating conditions:

		Manometer
(1)	Engine Compartment Door Open	0.0
(2)	Engine Compartment Louver removed	0.5
(3)	Engine Compartment Closed	0.6
(4)	Engine Compartment Louver 1/8 restricted	0.7
(5)	Engine Compartment Louver 1/4 restricted	0.8

TABLE 3-7
EMISSIONS DATA - 2100 ERPM RESTRICTING AIR INLET

Parameter/Door	Open	Lvr Rmvd	Closed	1/8 Res	1/4 Res
RPM	2118	2109	2118	2100	2118
SHP (Port Engine)	406	400	402	404	402
Fuel GPH (R&DC)	24.2	24.3	24.2	24.0	24.0
Air Flow (CFM)	1235	1234	1223	1246	1236
Air Inlet T (deg F)	90.1	96.6	96.0	97.5	99.3
Eng Compt T (deg F)	93	96.7	97.3	98	98
Relative Humidity (%)	29.7	30.0	30.7	29.3	29.0
Air Inlet Press (" Hg)	30.6	30.5	30.6	30.6	30.5
Manometer (" Wtr)	0.0	0.5	0.6	0.7	0.8
Combustion Eff (%)	63.9	64.2	63.2	63.9	64.3
Stack Temp (deg F)	749*	747	753	755	752
Oxygen (%)	11.6	11.6	11.5	11.5	11.6
CO (ppm)	590	607	601	615	608
CO2 (%)	6.9	6.9	6.9	6.9	6.9
COMB Gases (%)	.03	.02	.02	.03	.02
X's Air (ppm)	115	115	114	114	114
NO (ppm)	994	961	991	983	972
NO2 (ppm)	231	235	234	236	228
NOX (ppm)	1224	1196	1225	1219	1198
SO2 (ppm)	170	150	159	156	149
Boost Press ("Hg)	59	57.5	58	57	56.5
Ambient Air T (deg F)	50	50	50	50	50
Air In T - Ambient T	40.1	46.6	46.0	47.5	49.3

* Only two readings averaged. Initial reading discarded as warm up.

3.9 Engine Performance

Section 1.3 contained the following secondary objectives defined by reference [1]:

a. Determine whether the following parameters are within the manufacturer's recommended limits during all normal operations and towing operations:

1. engine room inlet pressure/vacuum
2. engine room/ambient air temperature differential
3. exhaust back pressure
4. exhaust temperature
5. raw water pressure
6. jacket water temperature

Because of equipment constraints only one engine could be completely instrumented for the emissions (including air flow and air inlet temperature), fuel flow, and Diesel Engine Maintenance Performance (DEMP) analog gauges (Boost Pressure and Exhaust Back Pressure). The port engine was selected for instrumentation.

Engine room inlet vacuum was measured using a water tube manometer connected to the engine compartment dewatering plug located on the aft portion of the boat. A direct correlation to ERPM was noted as summarized in TABLE 3-8:

TABLE 3-8
ERPM VS ENGINE COMPT VACUUM

ERPM	MANOMETER NORMAL	MANOMETER TOWING
2100	0.70	
1950	0.55	
1800	0.45	
1600	0.35	
1560	----	0.35
1400	0.25	0.20
1200	0.15	0.15
1000	0.10	
750	0.05	
550	0.00	

The engine room/ambient air temperature differential was measured using the Shortridge Instruments Inc. Air Flow Meter, Model ADM870 to measure the air inlet temperature with outside air temperature measured via a thermometer. The engine compartment temperature was measured using a thermometer attached to the top of the engine. Figures B-5 is a graph of the Port MDE Air Inlet Temperature and Engine Compartment Temperature versus Port ERPM. Figure B-6 is the Differential Temperature between the Port MDE Air Inlet and Outside Air Temperatures versus port ERPM

Exhaust back pressure was measured using the DEMP gauge attached to a 1/4" fitting located just downstream of the turbocharger and measuring the back pressure in inches of water. Figure B-4 is a graph of the Port MDE Exhaust Back Pressure versus Port ERPM.

It had been intended to measure the exhaust temperature using the thermography equipment. Because the thermography was discontinued these measurements were not possible.

Raw water pressure was not directly measured, however jacket water temperature, reduction gear lubricating oil temperature, and reduction gear lubricating oil pressure were measured. These parameters are correlated to the raw water pressure.

Jacket water temperature was measured during the testing using the installed sensor and collecting data manually and via the DDEC "Pro-Link 9000" Data Link. Figure B-9 is a graph of the Port MDE Jacket Water Temperature vs Port ERPM.

Other engine parameters were measured for both main engines using manual logs maintained by the boat engineer for the Speed-Power and Towing portions of the testing.

The DDEC "Pro-Link 9000" Data Link used by Detroit Diesel personnel for portions of the testing provided on-demand snapshots of ERPM, Throttle Set RPM, Engine Load Percentage, Coolant Temperature, Oil Pressure, Engine Oil Temperature, Boost Pressure (DDEC-psig), Barometric Pressure, and Fuel Consumption. Data were collected for towing, the upper limit of the trials displacement speed power (maximum and 2100 ERPM), and the bollard pull.

The engine parameter data gathered are presented in tabular and graphical form in Appendix B.

Comparison of the Port and Starboard engine parameters as provided in Tables B-1, B-5, and B-9 indicate that the starboard engine operating conditions run similar to the port engine although typically:

(1) The port turbocharger operates at a higher boost pressure then the starboard engine.
(2) The starboard engine jacket water temperature runs higher.
(3) The port reduction gear lubricating oil pressure runs higher then the starboard.

Based on this information Figures for the port engine only were generated since more complete data were available.

4.0 ANALYSIS

4.1 Principal Characteristics

Section 2-1 established the below criteria. The results based on the data collected during the TECHEVAL are shown in TABLE 4-1.

TABLE 4-1
SUMMARY OF PRINCIPAL CHARACTERISTICS

	Criteria	DDEC T&E
Draft (maximum load)	4'6"	< 3'0"
Displacement Hoisting Weight	39,742 lbs	40,350
Trial Condition Displacement	39,872 lbs	40,218
LCG for Trial Weight	16.5 ft fwd AP	16.5
Maximum Speed	$\geq$ 25 knots	26.2
Idle Speed	$\leq$6.0 knots	5.2

The draft was calculated for the worst case displacement 42,785 pounds, for the towing evolution which included ten personnel.

The load cells have an accuracy of ± 1%. If the error were bounded on the negative side this would still yield a hoisting weight higher than the target, indicating the boat has experienced weight growth. Without a detailed analysis of the boat weights the source of the growth can not be ascertained.

The maximum speed is from TABLE 3-3 for the trial condition. Idle speed was the same for 550 ERPM at both displacements.

4.2 Calm Water Power versus Speed

The power versus speed curve, Figure 3-1, for both the trials displacement and maximum displacement indicate consistent data for a displacement range that would encompass the typical operating conditions experienced by the 47-FT MLB.

4.3 Thermography

Data collection was discontinued as outlined in section 3.3.

4.4 Fuel Consumption

Section 2.4 established the following thresholds with a 20% fuel reserve:

(1) Range at Maximum Speed - 200 NM
(2) Endurance at Maximum Speed - 8 hours

The maximum fuel capacity of the 47-FT MLB is 411 gallons. At 95% this provides a starting point of 390 gallons. Assuming 25 gallons unusable fuel yields 365 gallons of fuel available. Dividing by 1.2 to account for the 20% fuel reserve desired yields a total of 305 gallons of fuel available for consumption under the above criteria.

The vessel speed will increase as fuel is consumed so an average of speeds for the trials and maximum displacements shown in TABLE 3-3 will be used or 25.5 knots. In addition, the fuel consumption for maximum power in TABLE 3-5 is consistent with a higher speed achieved at the lower displacement. Based on this a fuel consumption of 49.8 GPH will be used.

As previously discussed the R&DC fuel measurements ran slightly higher than the DDEC fuel readings which are based on a series of tables using ERPM, Engine Load Percentage, pulse width, and fuel temperature for entries. DDEC indicates a fuel consumption of 23.8 GPH per engine or 47.6 GPH for the boat.

Table 4-2, ENDURANCE and RANGE provides the calculated Endurance and Range using 305 gallons of fuel available at an average maximum speed of 25.5 knots. Here the measured (R&DC) and DDEC indicated consumption data is shown.

TABLE 4-2
ENDURANCE AND RANGE

	Criteria	R&DC	DDEC
Fuel Consumption (GPH)		49.8	47.6
Endurance (hours)	8	6.12	6.41
Range (NM)	200	156	163

The 47-FT MLB DDEC does not meet the criteria established in section 2.4

4.5 Acceleration

Section 2-5 established a criteria of comparison of the acceleration characteristics of the 6V-92 DDEC propulsion plant to the 6V-92 TA. Overall 47201, even with the DDEC smoke control feature ramps quicker than 47200 as demonstrated by Figure A-4.

4.6 Crash Stop Crash Reversal

Section 2-6 established a criteria of comparison of the deceleration characteristics of the 6V-92 DDEC propulsion plant to the 6V-92 TA.

A review of the data in Figure A-5 shows a flattening trend in each deceleration that occurred at approximately 8 seconds into every run. The data typically indicates a cross over point (dead stop) around 25 seconds for each run which appeared to be excessive.

After the flattening trend was initially detected, the R&DC requested that G-AWP arrange for timed Crash Stops with Station Cape May which were conducted on 01 DECEMBER 1994. Twelve runs were conducted, six in one direction and six on a reciprocal course using two personnel with stop watches with an average crash stop time of 8.02 seconds. This time compares favorably with the times measured during Builders Trials of the CG-47201 by Textron Marine Systems Inc. for the 6V-92 TA engine arrangement.

The tapes of the deceleration runs as recorded on the TEAC Digital Tape Recorder were subsequently post-processed using a Strip Chart Recorder to examine time series data for Torque, SRPM, and SHP for both shafts. In each instance the SRPM went to zero for a long period at approximately 8 seconds into the run.

As previously discussed in section 3.6, the decelerations were conducted in the evening of THURSDAY 10 NOVEMBER due to the weather forecast. The acceleration and deceleration runs were run after the trials displacement Speed-Power runs had been completed and the boat partially refueled. Because the decelerations were accomplished in the evening, the boat coxswain was unable to determine when the boat was stopped dead in the water. The post-process data clearly indicates that the throttles were placed in neutral while the boat still had way on which would cause the flattening trend evident in Figure A-5.

Assuming a linear relationship for the data prior to 8 seconds in Figure A-5 would project x-axis crossovers for all of the data before 10 seconds which can be used as an upper bound to compare to the timed data by Station Cape May.

4.7 Bollard Pull and U/W Towing

The threshold established in section 2.7 for bollard pull was for the boat to provide 9,500 lbs bollard pull with at least 10% reserve power.

As shown in TABLE 3-6 and Figures A-6 and A-7 the engine achieved a maximum pull of 8,200 pounds at 1330/1370 ERPM for the port and starboard shafts respectively. Thus the threshold was not achieved. As indicated in TABLE 3-6, the DDEC installation is utilizing a propeller with a higher P/D than that used for the 47200 Bollard Pull. Typically Bollard Pull is reduced as P/D is increased.

The threshold established in section 2.7 at-sea towing condition was to determine for the boat to tow a 110' WPB in calm water at 6 knots with at least 10% reserve power.

An average maximum towing speed of 8.9 knots at total of 589 SHP for both courses was obtained for the data in section 3.7. Review of the engine parameters will show that the engine was approaching the Torque Limits. Figure A-10 is a graph of the 47201 DDEC Tow Test for SHP and Speed Over Ground versus ERPM. At 1200 ERPM an average speed over ground (SOG) of 6.8 knots at a total of 276 SHP. Therefore the 47-FT MLB easily meets at-sea towing threshold established in section 2.7.

4.8 Emissions

The emissions data will be reduced, analyzed, and discussed in a future R&DC Report.

Review of TABLE 3-7 indicates two trends:

(1) The engine compartment temperature increased as the engine compartment vacuum increased.

(2) Air inlet temperature increased as the engine compartment temperature/engine compartment vacuum increased.

It should be noted that the "air inlet temperature" exceeds Detroit Diesel's recommended design parameter of not more than +30 degree differential from ambient outside air temperature in all conditions. It should also be noted that because of space restrictions, the location of the test apparatus for the air flow measurements was above the air box of the engine in lieu of the air inlet filter located just below the duct from the main deck. This resulted in air being heated prior to entry into the flow apparatus.

Comparison of the air and fuel flow data gathered during these tests to that gathered during the maximum displacement Speed-Power trials indicates that the data are consistent and repeatable.

4.9 Engine Performance

The following parameters were examined:

Engine Room Inlet Pressure/Vacuum

TABLE 3-8, ERPM VS ENGINE COMPT VACUUM shows a maximum of 0.7 inches of water vacuum. Detroit Diesel publishes a desired maximum vacuum of 0.3 inches of water.

Engine Room/Ambient air Temperature Differential

Comparison of the air temperatures shown for the emissions data in TABLE 3-7 and the differential graph shown in Figure B-6 indicates that the main diesel inlet air temperature exceeds Detroit Diesel's recommendation of not more than a 30 degree F temperature rise (Ambient Air to Engine Inlet) in both the door open and closed conditions.

A trend in TABLE 3-7 shows increasing temperature differential as back pressure is increased. This is in conflict with the data shown in Figure B-6 for the maximum displacement speed-power run and the towing exercise where the boat was operated with the engine compartment WTD open and closed. In each of these cases the Main Engine Air Inlet Temperature typically increased with the door open.

Exhaust Back Pressure

Large deflections were typically noted in the back pressure in the ERPM range of 1400 up to 1950. Figure B-4 represents maximum values for that range along with averaged values for the exhaust back pressures measured at ERPM outside that range. The excursion noted in the 1550-1950 ERPM range is consistent with measurements conducted by Detroit Diesel during trials of the DDEC installation in Baltimore, MD.

A plot of the DDEC exhaust back pressure limits is included and the current installation exceeded these at 1550 - 1700 ERPM for the trials displacement and for the range of 1550 - 1900 ERPM at the maximum displacement. It should be noted that the maximum displacement is more representative of the boat's typical operating displacement.

Exhaust Temperature

As discussed in Section 3.9 these data were not collected.

Raw Water Pressure

Although quantitative data were not gathered, review of Figures B-9, B-11, and B-12 indicate that the engine is operating within specified parameters for the Jacket Water Temperature, Lubricating Oil Temperature and Reduction Gear Oil Temperature indicating that the current raw water pressure is satisfactory.

Jacket Water Temperature

Figure B-9 shows that the Jacket Water Temperature was under 175 degrees Fahrenheit for all of the data points which is within the engine operating condition for coolant temperature.

Lubricating Oil Pressure (LOP)

Figure B-10 is a graph of the Port Main Diesel Engine Lubricating Oil Pressure (PSIG) versus Port ERPM. It should be noted that one data point fell on the DDEC Lubricating Oil pressure limit while another data point fell below the limit.

5.0 SUMMARY AND CONCLUSIONS

The Detroit Diesel 6V-92 DDEC engines meet the 47' MLB specification requirements dealing with speed.

The 47-FT MLB DDEC does not meet the criteria established in section 2.4 for endurance and range.

Figure 3-1 provides a detailed power versus speed curves, for the 47 MLB operating at typical loading conditions.

Figure A-10 provides a detailed power versus speed curves, during towing of a 110-FT WPB.

The 47-FT MLB, CG-47201, DDEC accelerates quicker than the 6V-92TA installed on the CG-47200 as indicated by Figure A-4.

Deceleration data were taken in the evening and the throttles were placed in neutral before all way was off the boat. Timed Crash-Stops indicate the DDEC has equivalent performance to the 6V-92 TA engine.

The main engine air inlet temperature rise phenomenon requires further examination. The location of the air inlet flow equipment may have been a significant contributor to the disparities noted. Any future testing should ensure that the duct entrance is directly in the normal air inlet path. Installation of a thermocouple in the air inlet should be considered.

The main engine exhaust back pressure operates out of specification in the ERPM range of 1550 - 1900. Quantitative observations during the testing indicated that the exhaust ports were covering and uncovering in this ERPM range. While the CG-47201 was operating in this ERPM range, the boat trim angle continued to increase due to the dynamic lift effects to a point where the maximum trim angle was reached after which the trim began to decrease. When 1900 ERPM was reached, the exhaust ports were totally uncovered once again and the back pressure had decreased to acceptable levels.

6.0 REFERENCES

[1] 6V-92 DDEC PROPULSION MODIFICATION TESTING AND EVALUATION PLAN, Enclosure (1) to G-AWP memorandum to G-ER 3963 dated 31 OCT 1994.

[2] M. Goodwin, "General Test Plan for Marine Vehicle Testing", June 1981 amended and reprinted July 1986.

[3] C. Kohler and R. Young, "Small Boat Test Plan", R&DC Report No CG-D-14-87

[4] Builders Trials Report for 47201

[5] D. Milburn, "Technical Characteristics Verification of the Prototype 47 FT MLB", R&DC Report CG-D-02-92

APPENDIX A

CG-47201 DDEC TESTING AND EVALUATION

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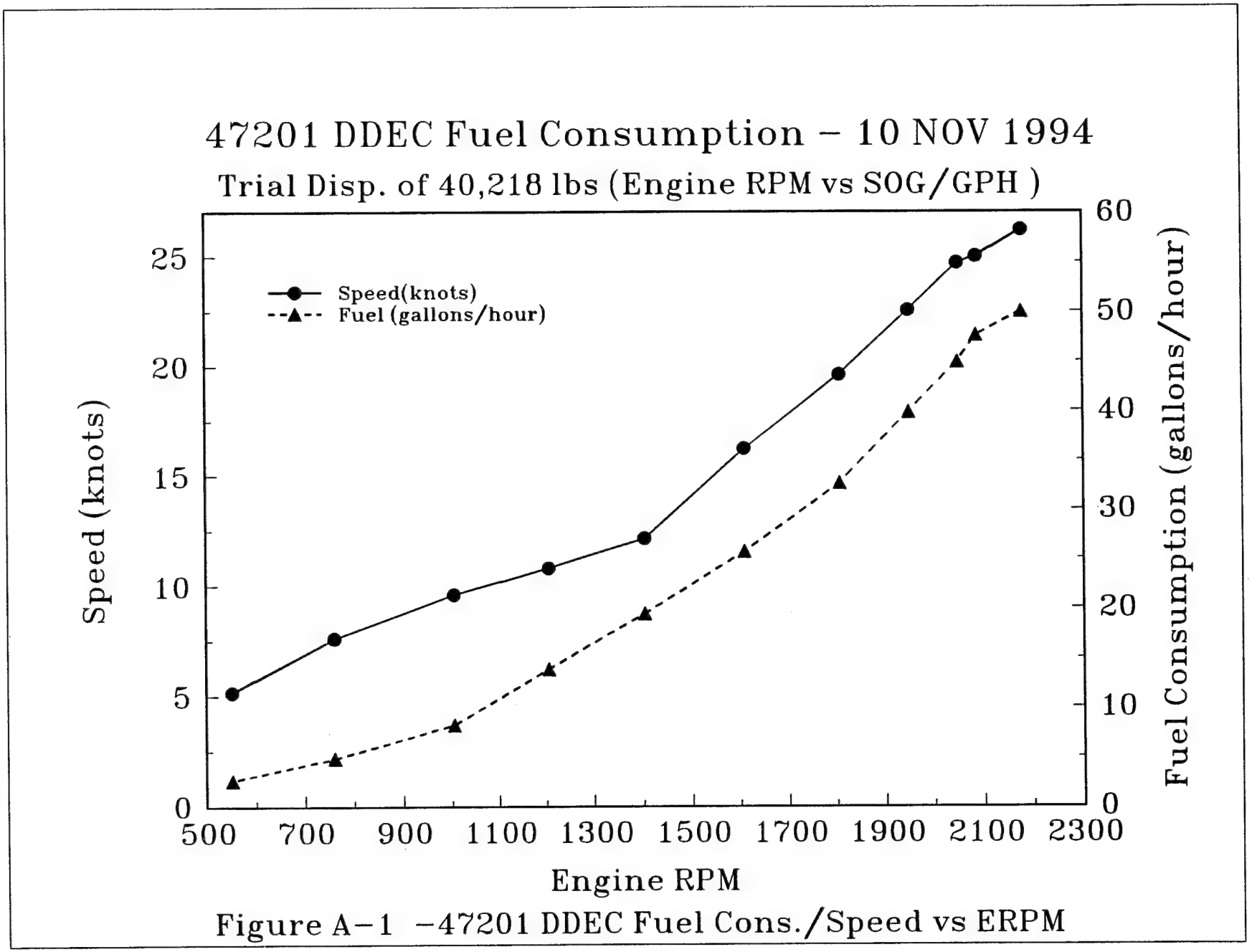

Figure A–1 –47201 DDEC Fuel Cons./Speed vs ERPM

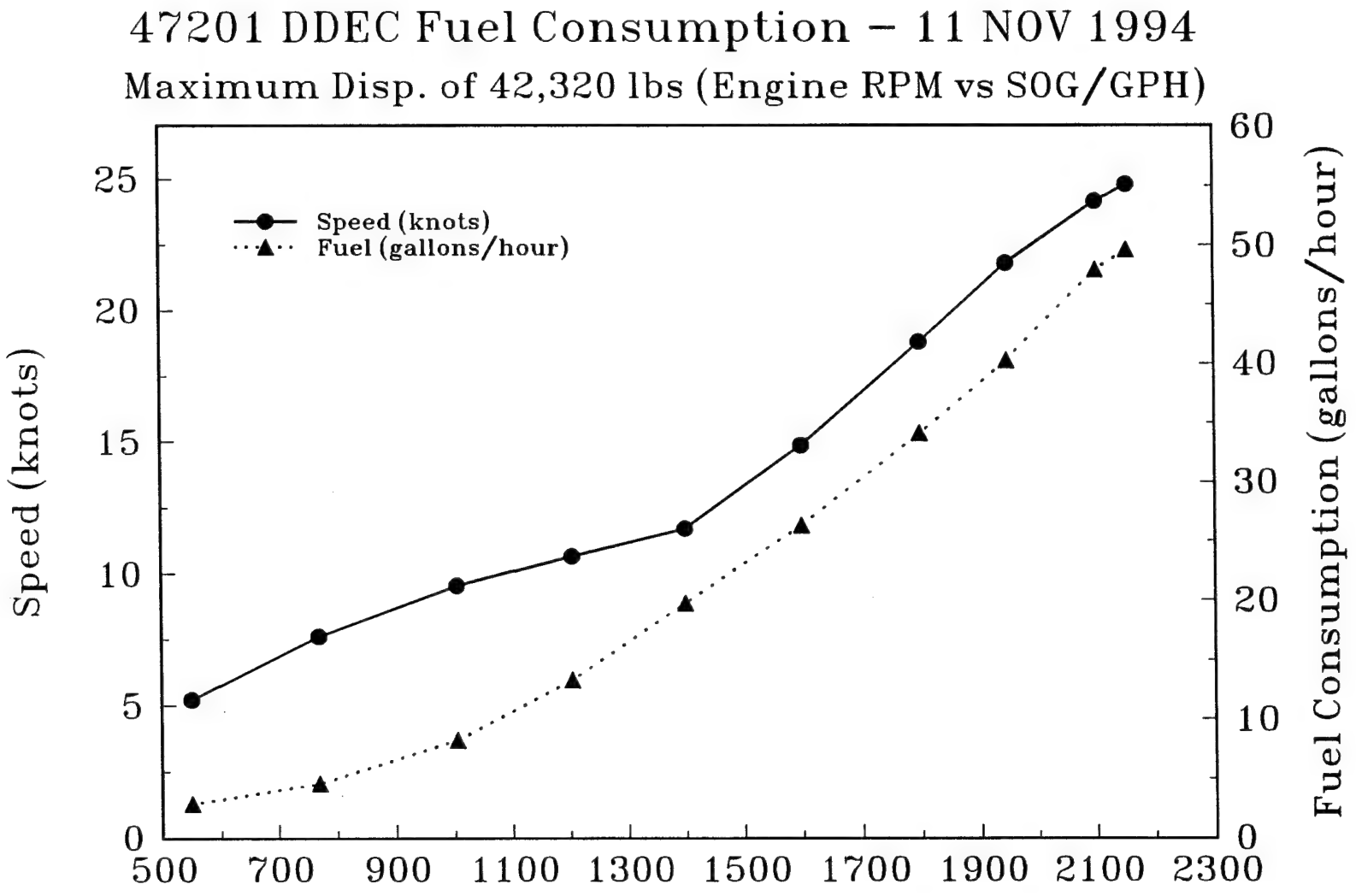

Figure A–2 – 47201 DDEC Fuel/Speed vs ERPM

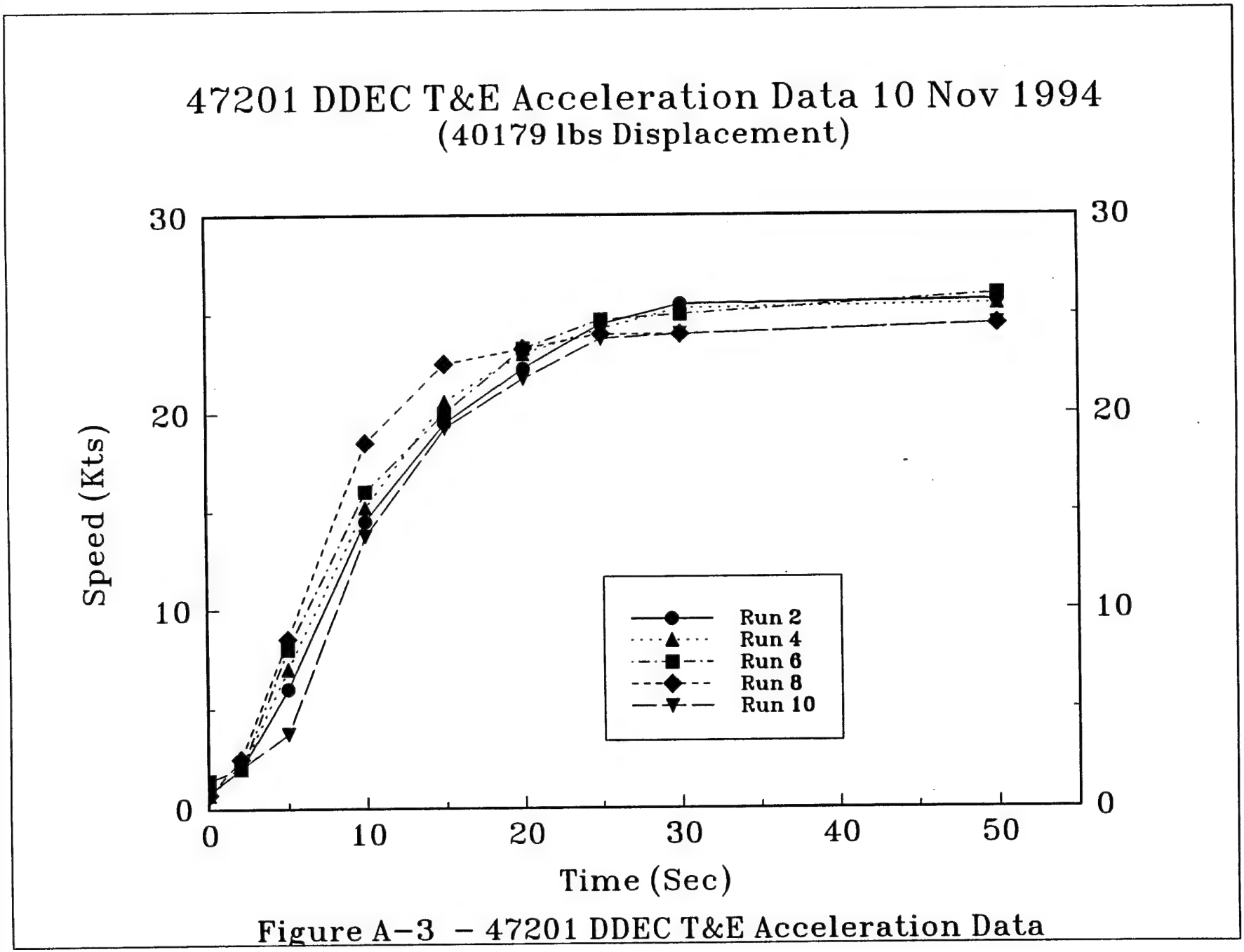

Figure A–3 – 47201 DDEC T&E Acceleration Data

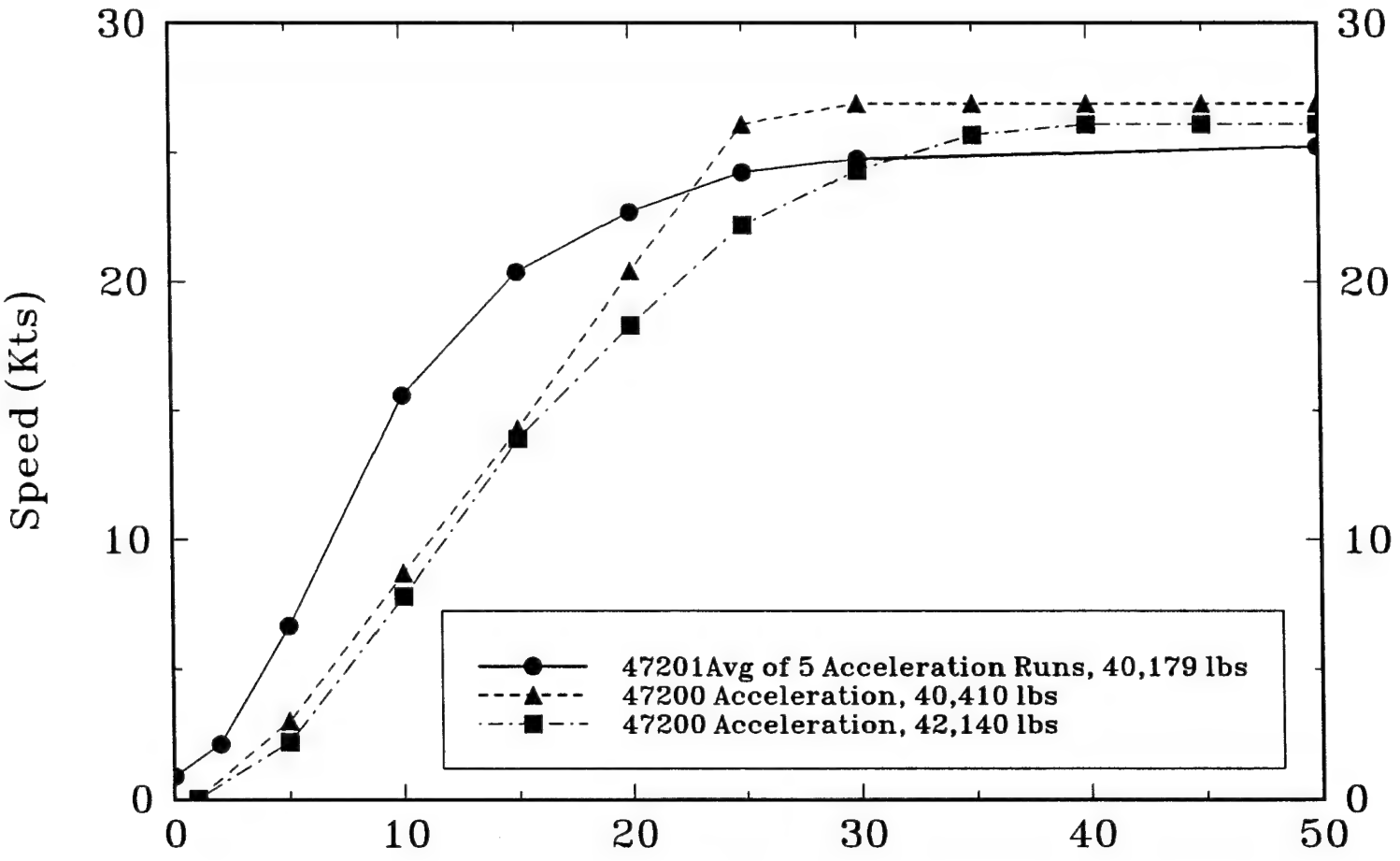

Figure A–4 – 47201 DDEC T&E Avg. Acceleration Data

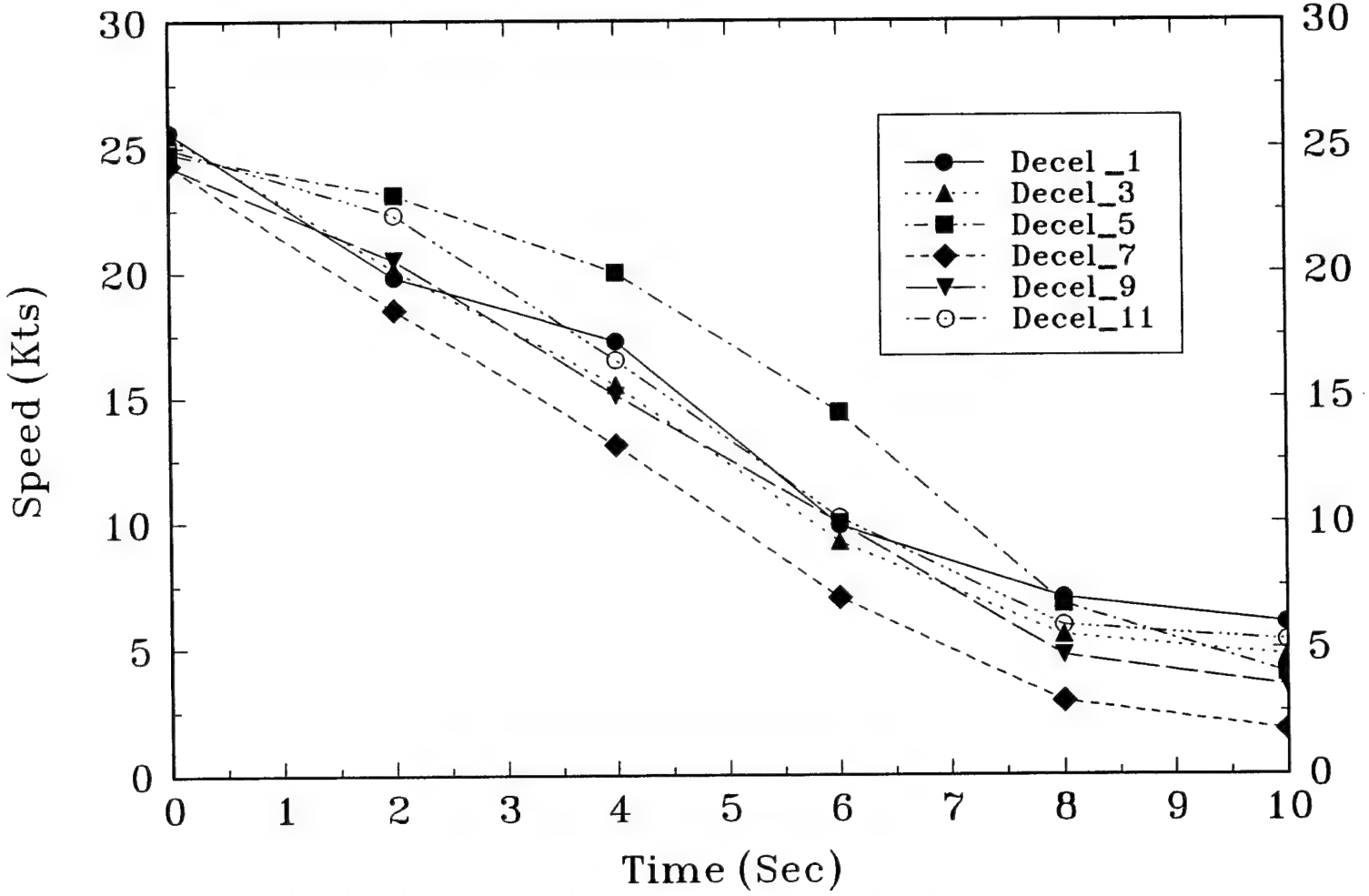

Figure A-5 - 47201 DDEC T&E Crash Stop Data

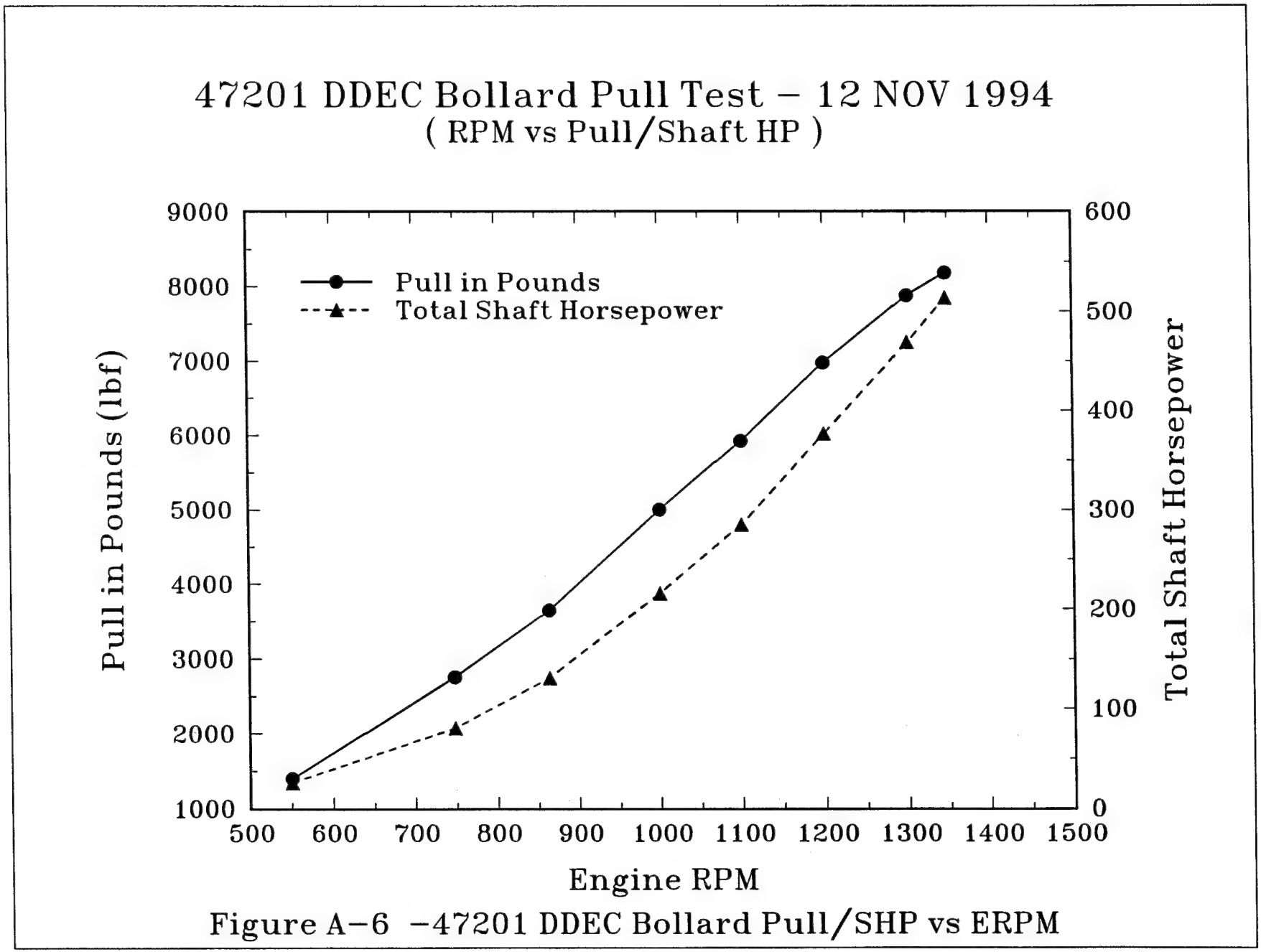

Figure A–6 –47201 DDEC Bollard Pull/SHP vs ERPM

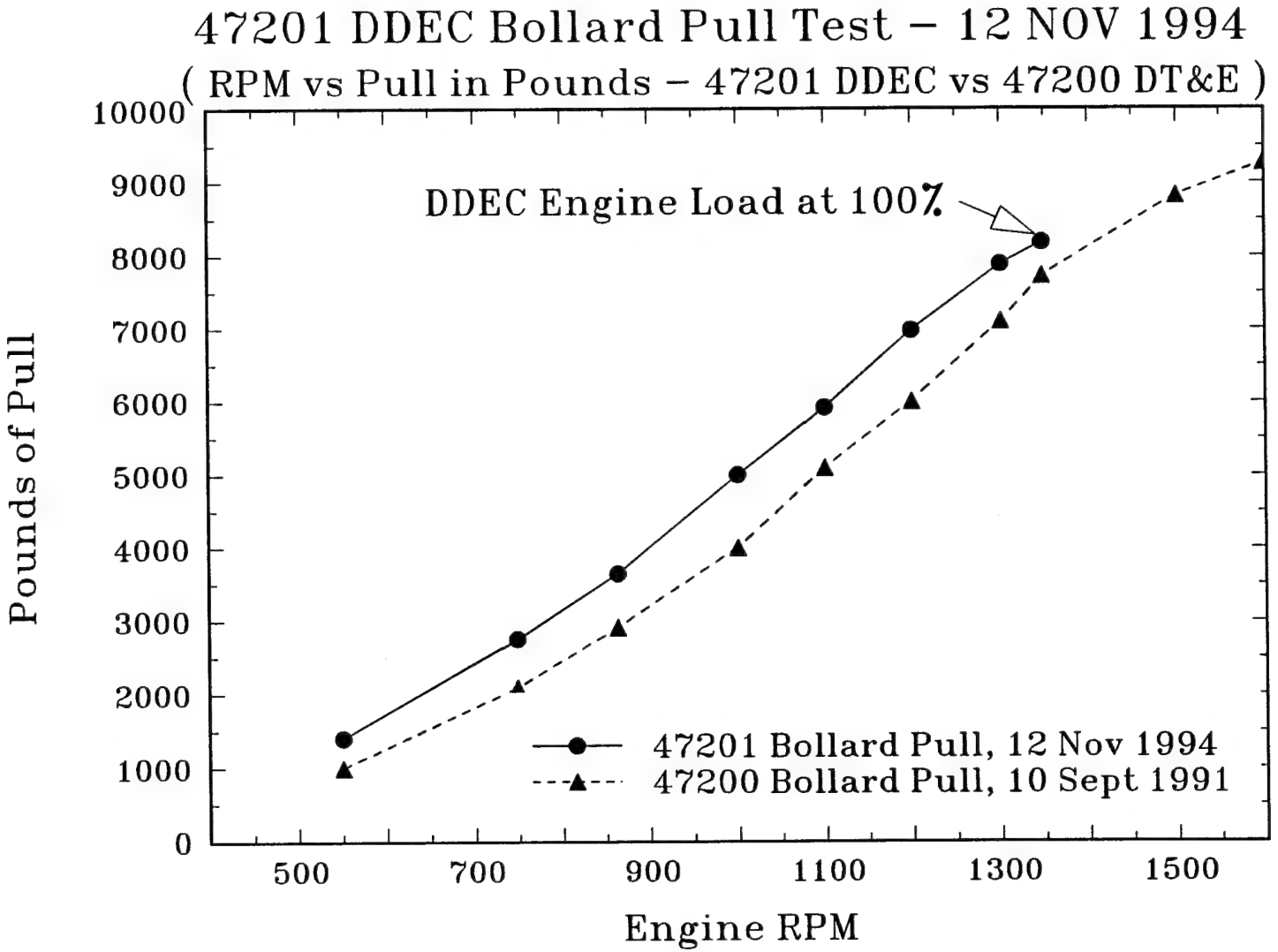

Figure A–7 – 47201 DDEC Bollard Pull Test Pull l vs ERPM 47201 and 47200

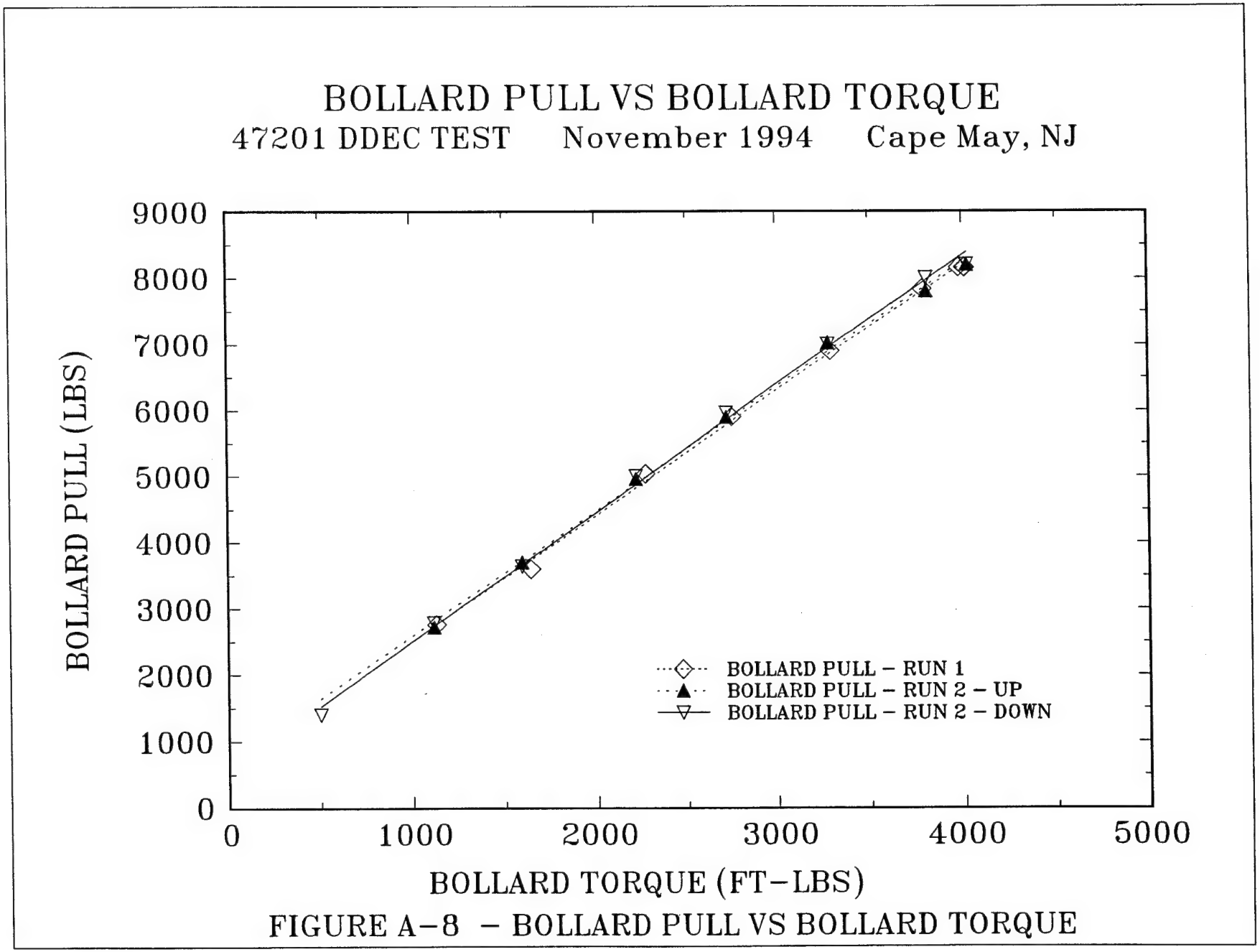

FIGURE A-8 – BOLLARD PULL VS BOLLARD TORQUE

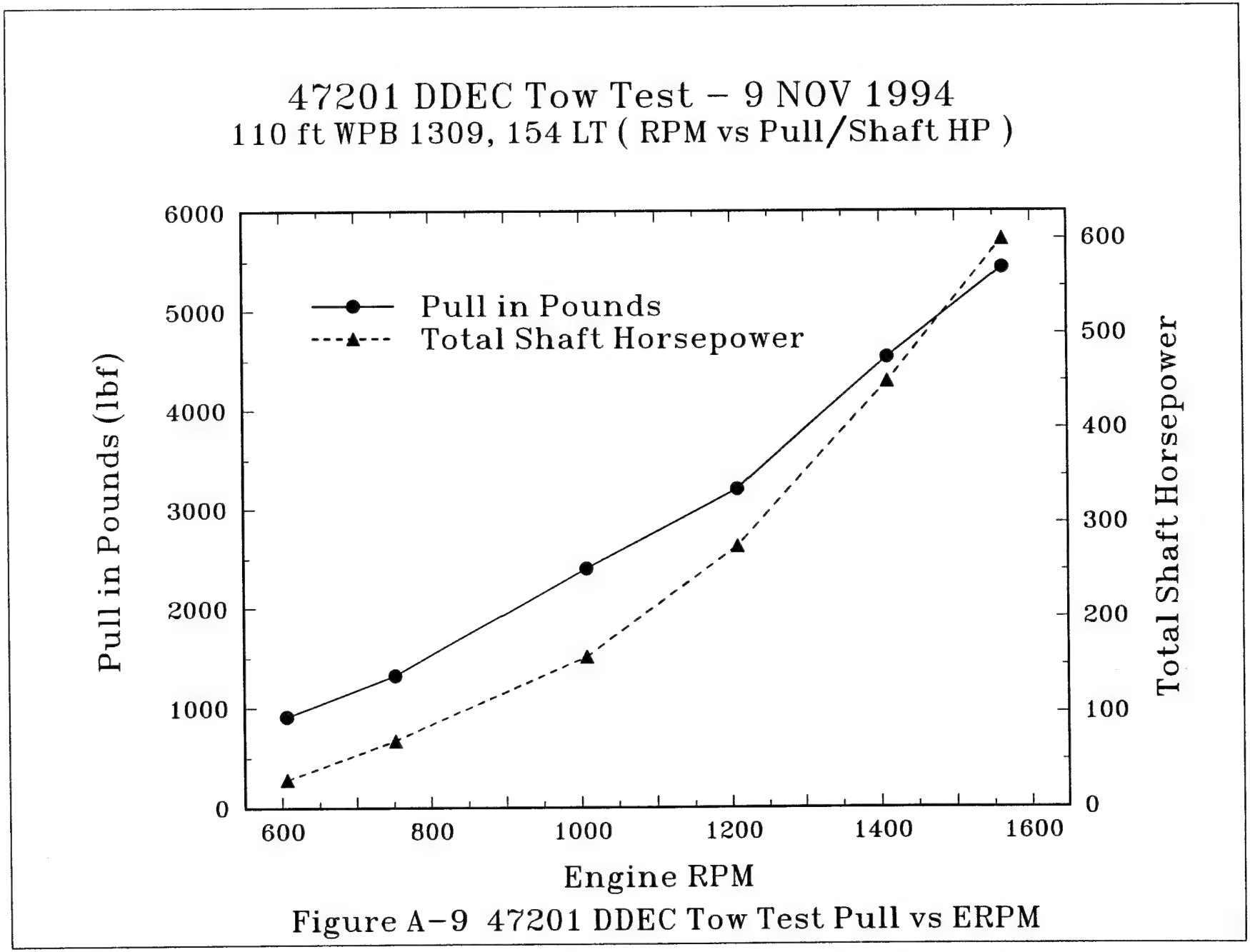

Figure A–9 47201 DDEC Tow Test Pull vs ERPM

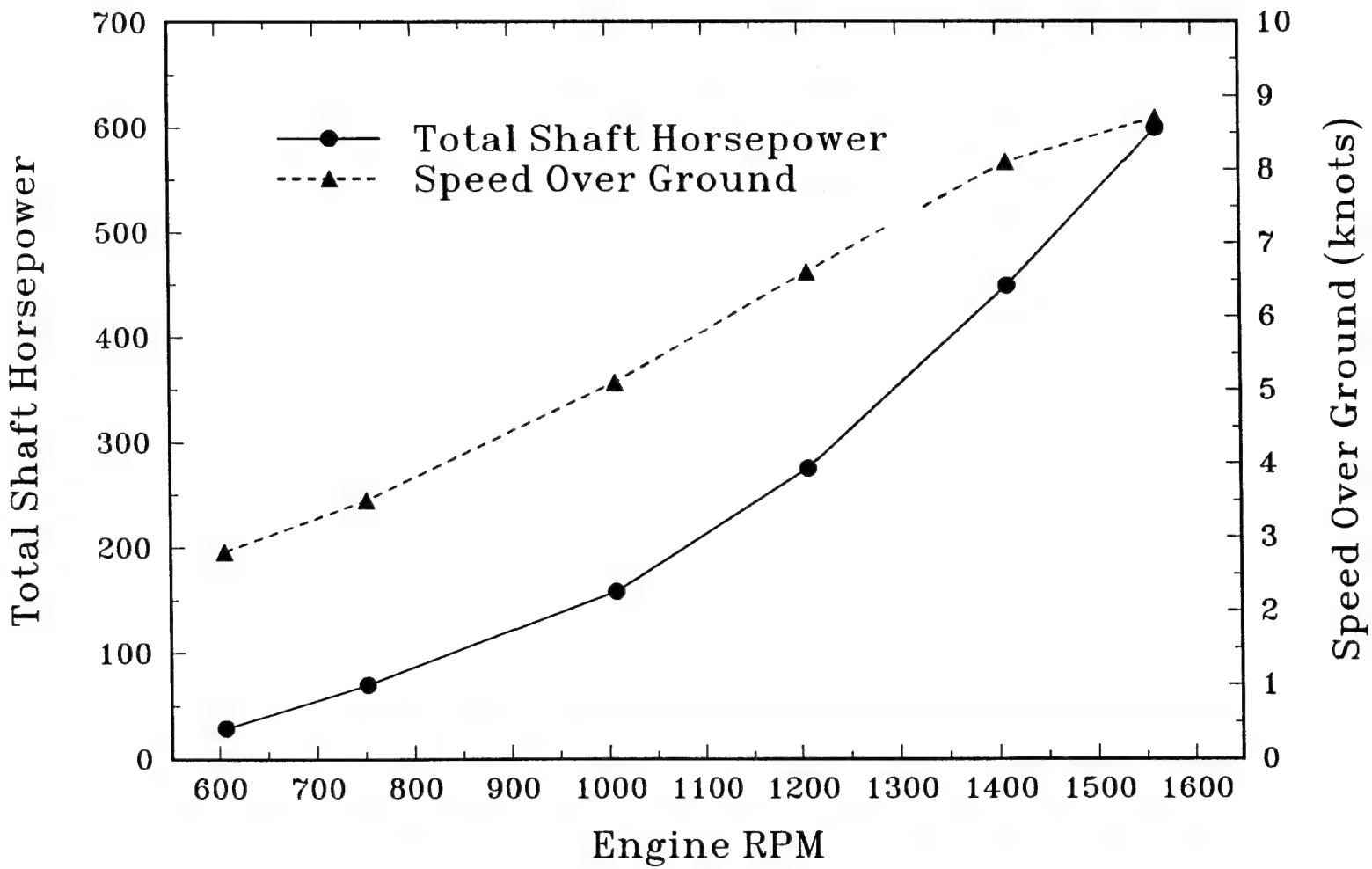

Figure A–10 –47201 DDEC Tow Test SHP/SOG vs ERPM

APPENDIX B

CG-47201 DDEC ENGINE PERFORMANCE TABLES AND GRAPHS

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TABLE B-1

MAIN ENGINE PARAMETERS SPEED-POWER TEST

ERPM	P SHP	S SHP	SPEED KTS	PORT LOAD %	STBD LOAD %	PORT TURBO PSI	STBD TURBO PSI	PORT FUELP PSI	STBD FUELP PSI	PORT JWTEM DEG F	STBD JWTEM DEG F	P LOP PSI	S LOP PSI	P LOT DEG F	S LOT DEG F	PORT GRTEM DEG F	STBD GRTEM DEG F	P GRP PSI	S GRP PSI
TRIALS DISPLACEMENT - 40,218 LBS																			
2146	420	421	26.3	100	100	28.5	27.7	62.0	63.0	170	172	59.0	60.0	205	195	169	172	275	265
2146-O	417	414	26.1	100	100	28.7	27.7	62.0	63.5	170	173	59.0	59.0	204	204	166	171	276	267
2100	395	379	25.0	94	97	27.5	25	61.0	63.0	169	172	58.0	59.0	203	203	171	175	276	264
2100-O	401	375	24.9	93	88	27.0	24	62.0	63.0	170	172	59	60	203	203	171	174	274	264
1950	340	325	22.6	85	81	22.5	20	61	62	168	171	59	61			161	162	275	264
1800	285	282	19.6	76	75	17.5	16.5	61	62	168	171	58	59			161	162	272	262
1600	222	225	16.3	71	68	13	12	61	61	166	170	58	58			157	157	272	260
1400	166	155	12.2	66	62	9	8	58	60	166	169	52	52			154	155	270	259
1200	102	106	10.8	45	44	4	4	58	58	163	168	44	44			151	147	268	256
1000	54	55	9.6	45	44	1	1	57	56	162	168	38	36			144	141	266	254
750	#	25	7.6	40	33	0	0	42	44	161	167	27	25			139	136	262	252
550	4	10	5.2	33	29	0	0	23	24	161	167	17	16			135	131	259	249
MAXIMUM DISPLACEMENT - 42,320 LBS																			
2140	421	423	24.8	100	100	28.7	28.4	60.0	60.5	169	172	60.0	60.0	201	201	150	156	276	264
2140-O	415	407	24.4	100	100	28.8	28.3	58.0	60.0	170	172	59.5	60.0	203	203	166	170	274	262
2100	412	397	24.2	97	95	28.5	26.5	59.0	59.0	169	171	57.0	60.0	203	200	168	171	274	262
2100-O	409	397	23.8	98	92	28.9	26.0	58.0	58.5	170	171	58.0	60.0	203	201	166	170	274	262
1950	360	346	21.8	87	82	24.3	21.5	57.0	57.0	168	170	55.0	60.0	197	195	151	156	273	262
1800	308	291	18.8	80	75	19.0	17.0	57.0	57.0	168	170	58.0	60.0	196	195	155	158	272	262
1700	264	255	16.4	76	73	16.7	15.0	55.0	55.0	168	170	57.0	59.0	194	193	156	157	270	260
1600	226	230	14.9	74	72	14.0	13.3	56.0	55.0	168	170	55.0	59.0	192	191	155	156	270	260
1500	202	205	13.2	74	71	12.3	10.8	54.0	55.0	166	169	52.0	57.0	189	189	153	154	268	258
1400	165	162	11.7*	64	65	9.4	9.0	54.0	53.5	165	168	51.5	52.0	186	187	151	150	268	258
1200	104	107	10.7	45	45	5.0	4.7	53.0	52.0	163	168	45.0	44.0	181	183	148	146	266	256
1000	54	57	9.5	46	43	1.6	1.4	52.0	51.0	162	167	37.0	36.0	176	179	142	141	264	254
750	#	26	7.6	38	33	0.5	0.4	40.0	45.5	161	167	24.5	25.0	171	173	138	136	260	252
550	3	10	5.2	32	25	0.0	0.0	22.5	25.0	160	166	16.5	16.0	166	169	134	130	258	251

TABLE B-2

MAIN ENGINE PARAMETERS SPEED-POWER TEST COMBINED DISPLACEMENTS

TRIALS DISPLACEMENT - 40,218 LBS MAXIMUM DISPLACEMENT - 42,320 LBS

ERPM	P SHP	S SHP	SPEED KTS	PORT LOAD %	STBD LOAD %	PORT TURBO PSI	STBD TURBO PSI	PORT FUELP PSI	STBD FUELP PSI	PORT JWTEM DEG F	STBD JWTEM DEG F	P LOP PSI	S LOP PSI	P LOT DEG F	S LOT DEG F	PORT GRTEM DEG F	STBD GRTEM DEG F	P GRP PSI	S GRP PSI
2146	420	421	26.3	100	100	28.5	27.7	62.0	63.0	170	172	59.0	60.0	205	195	169	172	275	265
2140	421	423	24.8	100	100	28.7	28.4	60.0	60.5	169	172	60.0	60.0	201	201	150	156	276	264
2146-O	417	414	26.1	100	100	28.7	27.7	62.0	63.5	170	173	59.0	59.0	204	204	166	171	276	267
2140-O	415	407	24.4	100	100	28.8	28.3	58.0	60.0	170	172	59.5	60.0	203	203	166	170	274	262
2100	395	379	25.0	94	97	27.5	25	61.0	63.0	169	172	58.0	59.0	203	203	171	175	276	264
2100	412	397	24.2	97	95	28.5	26.5	59.0	59.0	169	171	57.0	60.0	203	200	168	171	274	262
2100-O	401	375	24.9	93	88	27.0	24	62.0	63.0	170	172	59	60	203	203	171	174	274	264
2100-O	409	397	23.8	98	92	28.9	26.0	58.0	58.5	170	171	58.0	60.0	203	201	166	170	274	262
1950	340	325	22.6	85	81	22.5	20	61	62	168	171	59	61			161	162	275	264
1950	360	346	21.8	87	82	24.3	21.5	57.0	57.0	168	170	55.0	60.0	197	195	151	156	273	262
1800	285	282	19.6	76	75	17.5	16.5	61	62	168	171	58	59			161	162	272	262
1800	308	291	18.8	80	75	19.0	17.0	57.0	57.0	168	170	58.0	60.0	196	195	155	158	272	262
1600	222	225	16.3	71	68	13	12	61	61	166	170	58	58			157	157	272	260
1600	226	230	14.9	74	72	14.0	13.3	56.0	55.0	168	170	55.0	59.0	192	191	155	156	270	260
1400	166	155	12.2	66	62	9	8	58	60	166	169	52	52			154	155	270	259
1400	165	162	11.7*	64	65	9.4	9.0	54.0	53.5	165	168	51.5	52.0	186	187	151	150	268	258
1200	102	106	10.8	45	44	4	4	58	58	163	168	44	44			151	147	268	256
1200	104	107	10.7	45	45	5.0	4.7	53.0	52.0	163	168	45.0	44.0	181	183	148	146	266	256
1000	54	55	9.6	45	44	1	1	57	56	162	168	38	38			144	141	266	254
1000	54	57	9.5	46	43	1.6	1.4	52.0	51.0	162	167	37.0	36.0	176	179	142	141	264	254
750	#	25	7.6	40	33	0	0	42	44	161	167	27	28			139	136	262	252
750	#	26	7.6	38	33	0.5	0.4	40.0	45.5	161	167	24.5	25.0	171	173	138	136	260	252
550	4	10	5.2	33	29	0	0	23	24	161	167	17	16			135	131	259	249
550	3	10	5.2	32	25	0.0	0.0	22.5	25.0	160	166	16.5	16.0	166	169	134	130	258	251

TABLE B-3

PORT MAIN ENGINE PARAMETERS SPEED-POWER TEST

TRIALS DISPLACEMENT - 40,218 LB

ERPM	SHP (1)	SPEED KTS	FUEL GPH	AIRBX " HG	EXHBK " WTR	AIRFLW CFM	AIR TIN DEGF	AIR PIN " HG	ENG RMT DEGF	ER RH %	LOAD %	TURBO PSI	FUELP PSI	FUELT DEG F	JWTEM DEG F	LOP PSI	LOT DEG F	GRTEM DEG F	GRP PSI
2160	420	26.3	25.0	59.7	7.7						100	28	63	69	170	57		169	275
2110											100	28.5	61.0	68	170	59.0	205	170	274
2146-O	417	26.1	24.8	60.0	7.4						100	28	63	70	170	58		166	276
2202-O											100	28.8	60.5	70	170	59.0	203	160	276
2162-O											100	28.5	63.5	70	170	59.0	204	168	274
2104	395	25.0	23.9	56.3	7.1						98	27.5	62	70	170	58		171	276
2108											93	27.5	60.0	68	169	58.0	203	171	276
2104											94	26.9	61.5	70	169	58.0	203	171	274
2108-O	401	24.9	23.8	55.8	7.0						93	27	59	70	170	59		171	275
2110-O											93	27.0	62.0	69	170	59.0	203	171	274
2112-O											83	25.0	63.5	70	170	58.0	203	171	274
NOTE: DDEC PRO LINK DATA UNAVAILABLE AT TRIALS DISPLACEMENT FOR 1950 ERPM AND BELOW																			
1950	340	22.6	19.9	45.7	6.5						85	22.5	61	70	168	59		161	275
1800	285	19.6	16.3	37.8	8 -13						76	17.5	61	69	168	58		161	272
1600	222	16.3	12.8	26.5	11 -18						71	13	61	68	166	58		157	272
1400	166	12.2	9.7	19.0	2.0						66	9	58	67	166	52		154	270
1200	102	10.8	6.7	10.0	1.7						45	4	58	67	163	44		151	268
1000	54	9.6	4.1	3.6	1.4						45	1	57	67	162	38		144	266
750		7.6	2.4	1.5	0.8						40	0	42	68	161	27		139	262
550	4	5.2	1.3	0.5	0.5						33	0	23	69	161	17		135	259

TABLE B-3

PORT MAIN ENGINE PARAMETERS SPEED-POWER TEST (continued)

MAXIMUM DISPLACEMENT - 42,320 LBS

ERPM	SHP (1)	SPEED KTS	FUEL GPH	AIRBX " HG	EXHBK " WTR	AIRFLW CFM	AIR TIN DEGF	AIR PIN " HG	ENG RMT DEGF	ER RH %	LOAD %	TURBO PSI	FUELP PSI	FUELT DEG F	JWTEM DEG F	LOP PSI	LOT DEG F	GRTEM DEG F	GRP PSI
2141	421	24.8	24.8	60.3	7.5	1220/1243	87.6	30.4	90	28	100	28.5	59	68	170	59		160	275
2119											100	28.5	60.5	66	168	45.0	189	144	276
2135											100	28.8	60.0	67	169	60.0	201	155	276
2102-O	415	24.4	24.7	59.6	7.0	1227/1242	93.5	30.5	88	29	97	28	57	68	170	58		166	274
2156-O											100	28.8	59.5	66	170	58.0	203	159	274
2103	412	24.2	23.9	57.9	7.8	1216/1254	91.0	30.5	90	29	96	28	58	68	169	58		168	274
2105											96	28.5	59.0	68	169	58.0	203	168	274
2110											99	28.6	55.5	67	169	55.0	201	168	274
2103-O	409	24.1	23.8	58.3	7.0	1212/1228	93.0	30.5	89	28	97	28	59	68	174	57		167	275
2102-O											98	28.8	59.0	67	169	59.0	203	164	274
2099-O											100	29.0	57.0	66	170	40.0	203	166	274
2105-O											98	28.8	59.0	68	170	58.0	203	167	274
1950	360	21.8	20.1	48.5	6.5	1125/1151	87.0	30.5	91	24	85	23.5	57	68	168	55		151	273
1946											89	24.5	56.0	67	166	50.0	189	146	274
1951											85	24.2	58.5	67	168	57.0	197	152	272
1800	308	18.8	17.0	38.5	10 - 22	1015/1052	87.7	30.6	90	26	80	18.5	56	67	168	58		155	272
1799											84	19.3	57.0	67	168	49.0	196	155	270
1800											80	19.0	56.5	67	168	59.0	195	155	272
1702	264	16.4		33.5	16 - 22						76	16	55	66	167	56		156	270
1707											74	17.1	54.5	66	168	57.0	195	156	270
1704											76	16.4	55.5	66	168	57.0	193	156	270

TABLE B-3

PORT MAIN ENGINE PARAMETERS SPEED-POWER TEST (continued)

MAXIMUM DISPLACEMENT - 42,320 LBS

ERPM	SHP (1)	SPEED KTS	FUEL GPH	AIRBX " HG	EXHBK " WTR	AIRFLW CFM	AIR TIN DEGF	AIR PIN " HG	ENG RMT DEGF	ER RH %	LOAD %	TURBO PSI	FUELP PSI	FUELT DEG F	JWTEM DEG F	LOP PSI	LOT DEG F	GRTEM DEG F	GRP PSI
1600	226	14.9	13.1	29.5	10 - 16	999/1118	87.6	30.55	91	27	74	14	54	67	166	55		155	270
1602											83	17.1	58.0	66	168	46.0	192	155	270
1598											74	14.0	55.0	66	167	58.0	191	154	270
1502	202	13.2		24.3	4.5- 10						74	12	53	66	166	52		153	268
1501											71	11.6	54.5	66	167	55.0	189	154	268
1504											74	12.9	53.5	66	166	45.0	188	153	268
1401	165	11.7*	9.9	19.7	2.5	805/ 890	90.4	30.5	92	27	63	9	55	67	164	51		151	268
1401											62	8.8	54.0	66	165	50.0	188	152	268
1399											67	9.9	54.0	66	165	53.0	185	151	268
1203	104	10.7	6.6	10.2	2.0	645/ 742	102.0	30.5	94	26	45	4	53	66	162	44		148	266
1205											44	4.9	53.5	66	163	45.0	183	150	266
1202											46	5.1	53.0	67	163	45.0	180	147	266
1001	54	9.5	4.1	3.8	2.0	463/ 513	110.2	30.5	97	26	45	1	52	67	162	37		142	264
999											47	1.8	51.5	66	162	35.0	177	145	264
1002											46	1.5	53.0	67	162	37.0	176	142	264
751	#	7.6	2.3	1.5	1.0	264/ 285	112.5	30.6	101	25	38	0	41	67	160	25		138	260
750											38	0.5	40.0	67	161	24.0	173	140	260
751											41	0.5	39.0	67	161	25.0	170	138	260
550	3	5.2	1.4	0.5	0.5	222/ 261	112.8	30.5	102	25	32	0	22	67	160	17		134	254
551											32	0.0	23.0	67	161	16.0	169	136	258
552											31	0.0	22.5	67	160	17.0	166	134	258

TABLE B-4

PORT MAIN ENGINE PARAMETERS SPEED-POWER TEST COMBINED DISPLACEMENTS

TRIALS DISPLACEMENT - 40,218 LBS MAXIMUM DISPLACEMENT - 42,320 LBS

ERPM	SHP (1)	SPEED KTS	FUEL GPH	AIRBX " HG	EXHBK " WTR	AIRFLW CFM	TIN DEGF	PIN " HG	RMT DEGF	RH %	LOAD %	TURBO PSI	FUELP PSI	FUELT DEG F	JWTEM DEG F	LOP PSI	LOT DEG F	GRTEM DEG F	GRP PSI
2160	420	26.3	25.0	59.7	7.7						100	28	63	69	170	57		169	275
2110											100	28.5	61.0	68	170	59.0	205	170	274
2141	421	24.8	24.8	60.3	7.5	1220/1243	87.6	30.4	90	28	100	28.5	59	68	170	59		160	275
2119											100	28.5	60.5	66	168	45.0	189	144	276
2135											100	28.8	60.0	67	169	60.0	201	155	276
2146-O	417	26.1	24.8	60.0	7.4						100	28	63	70	170	58		166	276
2202-O											100	28.8	60.5	70	170	59.0	203	160	276
2162-O											100	28.5	63.5	70	170	59.0	204	168	274
2102-O	415	24.4	24.7	59.6	7.0	1227/1242	93.5	30.5	88	29	97	28	57	68	170	58		166	274
2156-O											100	28.8	59.5	66	170	58.0	203	159	274
2104	395	25.0	23.9	56.3	7.1						98	27.5	62	70	170	58		171	276
2108											93	27.5	60.0	68	169	58.0	203	171	276
2104											94	26.9	61.5	70	169	58.0	203	171	274
2103	412	24.2	23.9	57.9	7.8	1216/1254	91.0	30.5	90	29	96	28	58	68	169	58		168	274
2105											96	28.5	59.0	68	169	58.0	203	168	274
2110											99	28.6	55.5	67	169	55.0	201	168	274
2108-O	401	24.9	23.8	55.8	7.0						93	27	59	70	170	59		171	275
2110-O											93	27.0	62.0	69	170	59.0	203	171	274
2112-O											83	25.0	63.5	70	170	58.0	203	171	274
2103-O	409	24.1	23.8	58.3	7.0	1212/1228	93.0	30.5	89	28	97	28	59	68	174	57		167	275
2102-O											98	28.8	59.0	67	169	59.0	203	164	274
2099-O											100	29.0	57.0	66	170	40.0	203	166	274
2105-O											98	28.8	59.0	68	170	58.0	203	167	274
1950	340	22.6	19.9	45.7	6.5						85	22.5	61	70	168	59		161	275
1950	360	21.8	20.1	48.5	6.5	1125/1151	87.0	30.5	91	24	85	23.5	57	68	168	55		151	273
1946											89	24.5	56.0	67	166	50.0	189	146	274
1951											85	24.2	58.5	67	168	57.0	197	152	272

TABLE B-4

PORT MAIN ENGINE PARAMETERS SPEED-POWER TEST COMBINED DISPLACEMENTS (continued)

TRIALS DISPLACEMENT - 40,218 LBS MAXIMUM DISPLACEMENT - 42,320 LBS

ERPM	SHP (1)	SPEED KTS	FUEL GPH	AIRBX " HG	EXHBK " WTR	AIRFLW CFM	TIN DEGF	PIN " HG	RMT DEGF	RH %	LOAD %	TURBO PSI	FUELP PSI	FUELT DEG F	JWTEM DEG F	LOP PSI	LOT DEG F	GRTEM DEG F	GRP PSI
1800	285	19.6	16.3	37.8	8 -13						76	17.5	61	69	168	58		161	272
1800	308	18.8	17.0	38.5	10 - 22	1015/1052	87.7	30.6	90	26	80	18.5	56	67	168	58		155	272
1799											84	19.3	57.0	67	168	49.0	196	155	270
1800											80	19.0	56.5	67	168	59.0	195	155	272
1600	222	16.3	12.8	26.5	11 -18						71	13	61	68	166	58		157	272
1600	226	14.9	13.1	29.5	10 - 16	999/1118	87.6	30.55	91	27	74	14	54	67	166	55		155	270
1602											83	17.1	58.0	66	168	46.0	192	155	270
1598											74	14.0	55.0	66	167	58.0	191	154	270
1502	202	13.2		24.3	4.5- 10						74	12	53	66	166	52		153	268
1501											71	11.6	54.5	66	167	55.0	189	154	268
1504											74	12.9	53.5	66	166	45.0	188	153	268
1400	166	12.2	9.7	19.0	2.0						66	9	58	67	166	52		154	270
1401	165	11.7*	9.9	19.7	2.5	805/ 890	90.4	30.5	92	27	63	9	55	67	164	51		151	268
1401											62	8.8	54.0	66	165	50.0	188	152	268
1399											67	9.9	54.0	66	165	53.0	185	151	268
1200	102	10.8	6.7	10.0	1.7						45	4	58	67	163	44		151	268
1203	104	10.7	6.6	10.2	2.0	645/ 742	102.0	30.5	94	26	45	4	53	66	162	44		148	266
1205											44	4.9	53.5	66	163	45.0	183	150	266
1202											46	5.1	53.0	67	163	45.0	180	147	266
1000	54	9.6	4.1	3.6	1.4						45	1	57	67	162	38		144	266
1001	54	9.5	4.1	3.8	2.0	463/ 513	110.2	30.5	97	26	45	1	52	67	162	37		142	264
999											47	1.8	51.5	66	162	35.0	177	145	264
1002											46	1.5	53.0	67	162	37.0	176	142	264

TABLE B-4

PORT MAIN ENGINE PARAMETERS SPEED-POWER TEST COMBINED DISPLACEMENTS (continued)

TRIALS DISPLACEMENT - 40,218 LBS MAXIMUM DISPLACEMENT - 42,320 LB

ERPM	SHP (1)	SPEED KTS	FUEL GPH	AIRBX " HG	EXHBK " WTR	AIRFLW CFM	TIN DEGF	PIN " HG	RMT DEGF	RH %	LOAD %	TURBO PSI	FUELP PSI	FUELT DEG F	JWTEM DEG F	LOP PSI	LOT DEG F	GRTEM DEG F	GRP PSI
750		7.6	2.4	1.5	0.8						40	0	42	68	161	27		139	262
751	#	7.6	2.3	1.5	1.0	264/ 285	112.5	30.6	101	25	38	0	41	67	160	25		138	260
750											38	0.5	40.0	67	161	24.0	173	140	260
751											41	0.5	39.0	67	161	25.0	170	138	260
550	4	5.2	1.3	0.5	0.5						33	0	23	69	161	17		135	259
550	3	5.2	1.4	0.5	0.5	222/ 261	112.8	30.5	102	25	32	0	22	67	160	17		134	254
551											32	0.0	23.0	67	161	16.0	169	136	258
552											31	0.0	22.5	67	160	17.0	166	134	258

TABLE B-5

MAIN ENGINE PARAMETERS TOWING USCGC AQUIDNECK

DISPLACEMENT - 42,785 LBS

ERPM	P SHP	S SHP	SPEED KTS	PORT LOAD %	STBD LOAD %	PORT TURBO PSI	STBD TURBO PSI	PORT FUELP PSI	STBD FUELP PSI	PORT JW T DEGF	STBD JW T DEGF	P LOP PSI	S LOP PSI	P LOT DEGF	S LOT DEGF	PORT GR T DEGF	STBD GR T DEGF	P GRP PSI	S GRP PSI	LOAD LBS
604/ 603	11	18	2.8	38	34	0	0	29	31	162	168	19	18			123	118	262	250	912
601/ 606				40	33	0.1	0.1	28.0	31.5	162	168	19.0	18.0	169	172	123	118	262	250	
749/ 749	#	35	3.5	50	44	0	0	42	48	164	168	26	27			125	119	262	250	1,321
754/ 753				48	46	0.5	0.4	42.0	48.0	164	168	25.0	23.0	173	175	125	120	262	250	
1008/1008	76	82	5.1	53	53	2	2	57	58	165	169	37	34			128	126	266	256	2,398
1014/1006				53	54	2.1	2.0	57.0	58.0	165	169	38.0	34.0	179	181	128	126	264	252	
1207/1207	135	140	6.6	56	56	6	6	59	59	166	170	45	42			136	135	266	258	3,200
1212/1208				57	57	6.5	6.3	58.5	59.0	166	170	44.0	43.0	184	185	136	135	266	258	
1410/1410	222	227	8.1	85	85	13	13	60	59	168	171	51	51			144	145	268	256	4,531
1411/1410				86	88	13.8	13.3	59.0	60.0	168	171	50.0	50.0	191	191	144	145	268	256	
1560/1560	298	301	8.7	100	100	19	18	55	60	169	172	56	56			153	154	270	258	5,434
1565/1548				96	99	19.9	18.5	62.5	61.0	169	172	55.0	46.0	196	195	153	154	272	258	
1560-O	299	300	8.7																	5,334
RECIPROCAL COURSE																				
1560-O	294	285	9.2																	5,598
1560/1560	282	280	9.3	100	92	18	16	61	60	169	171	55	56			151	151	270	260	4,958
1553/1545				94	100	18.3	18.9	56.0	61.5	170	171	56.0	55.0	195	195	151	151	270	258	
1410/1410	219	220	8.5	85	76	13	12	60	60	168	170	51	51			156	155	268	256	4,602
1408/1404				86	88	13.4	12.6	60.0	59.5	168	171	52.0	50.0	192	191	156	155	268	256	
1207/1207	138	138	7.1	55	53	6	5	56	59	165	169	45	42			153	151	268	256	3,400
1207/1215				52	49	5.8	5.8	57.0	59.0	165	169	45.0	43.0	185	185	152	150	268	256	

TABLE B-5

MAIN ENGINE PARAMETERS TOWING USCGC AQUIDNECK (continued)

DISPLACEMENT - 42,785 LBS

ERPM	P SHP	S SHP	SPEED KTS	PORT LOAD %	STBD LOAD %	PORT TURBO PSI	STBD TURBO PSI	PORT FUELP PSI	STBD FUELP PSI	PORT JW T DEGF	STBD JW T DEGF	P LOP PSI	S LOP PSI	P LOT DEGF	S LOT DEGF	PORT GR T DEGF	STBD GR T DEGF	P GRP PSI	S GRP PSI	LOAD LBS
1003/1003	76	79	6.0	53	50	2	1	57	57	163	169	34	35			148	145	266	256	2,434
1005/1005				51	53	2.0	2.0	55.5	57.5	164	169	36.0	33.0	179	181	149	146	266	256	
750/ 750	#	33	4.6	44	38	0	0	41	48	162	168	27	29			143	139	262	256	1,224
753/ 748				46	42	0.4	0.4	42.0	48.0	162	168	25.0	22.0	173	176	144	140	264	248	

600 - NOT PERFORMED ON RECIPROCAL COURSE XXX

TABLE B-6
MAIN ENGINE PARAMETERS TOWING USCGC AQUIDNECK - BOTH COURSES
DISPLACEMENT - 42,785 LBS

xxxx - INITIAL COURSE YYYY - RECIPROCAL COURSE

ERPM	P SHP	S SHP	SPEED KTS	PORT LOAD %	STBD LOAD %	PORT TURBO PSI	STBD TURBO PSI	PORT FUELP PSI	STBD FUELP PSI	PORT JW T DEGF	STBD JW T DEGF	P LOP PSI	S LOP PSI	P LOT DEGF	S LOT DEGF	PORT GR T DEGF	STBD GR T DEGF	P GRP PSI	S GRP PSI	LOAD LBS
604/ 603	11	18	2.8	38	34	0	0	29	31	162	168	19	18			123	118	262	250	917
601/ 606				40	33	0.1	0.1	28.0	31.5	162	168	19.0	18.0	169	172	123	118	262	250	
600 - NOT PERFORMED ON RECIPROCAL COURSE																				XXX
749/ 749	#	35	3.5	50	44	0	0	42	48	164	168	26	27			125	119	262	250	1,321
754/ 753				48	46	0.5	0.4	42.0	48.0	164	168	25.0	23.0	173	175	125	120	262	250	
750/ 750	#	33	4.6	44	38	0	0	41	48	162	168	27	29			143	139	262	256	1,224
753/ 748				46	42	0.4	0.4	42.0	48.0	162	168	25.0	22.0	173	176	144	140	264	248	
1008/1008	76	82	5.1	53	53	2	2	57	58	165	169	37	34			128	126	266	256	2,398
1014/1006				53	54	2.1	2.0	57.0	58.0	165	169	38.0	34.0	179	181	128	126	274	252	
1003/1003	76	79	6.0	53	50	2	1	57	57	163	169	34	35			148	145	266	256	2,434
1005/1005				51	53	2.0	2.0	55.5	57.5	164	169	36.0	33.0	179	181	149	146	266	256	
1207/1207	135	140	6.6	56	56	6	6	59	59	166	170	45	42			136	135	266	258	3,200
1212/1208				57	57	6.5	6.3	58.5	59.0	166	170	44.0	43.0	184	185	136	135	266	258	
1207/1207	138	138	7.1	55	53	6	5	56	59	165	169	45	42			153	151	268	256	3,400
1207/1215				52	49	5.8	5.8	57.0	59.0	165	169	45.0	43.0	185	185	152	150	268	256	
1410/1410	222	227	8.1	85	85	13	13	60	59	168	171	51	51			144	145	268	256	4,531
1411/1410				86	88	13.8	13.3	59.0	60.0	168	171	50.0	50.0	191	191	144	145	268	256	
1410/1410	219	220	8.5	85	76	13	12	60	60	168	170	51	51			156	155	268	256	4,602
1408/1404				86	88	13.4	12.6	60.0	59.5	168	171	52.0	50.0	192	191	156	155	268	256	
1560/1560	298	301	8.7	100	100	19	18	55	60	169	172	56	56			153	154	270	258	5,434
1565/1548				96	99	19.9	18.5	62.5	61.0	169	172	55.0	46.0	196	195	153	154	272	258	
1560/1560	282	280	9.3	100	92	18	16	61	60	169	171	55	56			151	151	270	260	4,958
1553/1545				94	100	18.3	18.9	56.0	61.5	170	171	56.0	55.0	195	195	151	151	270	258	
1560-O	299	300	8.7																	5,334
1560-O	294	285	9.2																	5,598

TABLE B-7

PORT MAIN ENGINE PARAMETERS TOWING USCGC AQUIDNECK

DISPLACEMENT - 42,785 LBS

ERPM	SHP (1)	SPEED KTS	FUEL GPH	AIRBX " HG	EXHBK " WTR	AIRFLW CFM	AIR T IN DEG F	AIR P IN " HG	ERT DEGF	ER RH %	LOAD %	TURBO PSI	FUELP PSI	FUELT DEG F	JWT DEGF	LOP PSI	LOT DEGF	GRT DEGF	GRP PSI	PULL LBS
604	11	2.8	1.9	0.7	0.5		109.6	30.1	104	34	38	0	29	67	162	19		123	262	912
601			2.2								40	0.1	28.0	67	162	19.0	169	123	262	
749	#	3.5	2.8	1.0	0.9		110.7	30.1	105	34	50	0	42	67	164	26		125	262	1,321
753			3.1								48	0.5	42.0	67	164	25.0	173	125	262	
1008	76	5.1	5.2	5.0	1.5		110.1	30.1	107	32	53	2	57	67	165	37		128	266	2,398
1014			5.0								53	2.1	57.0	67	165	38.0	179	128	264	
1207	135	6.6	8.4	13.4	2.0		104.8	30.1	106	32	56	6	59	72	166	45		136	266	3,200
1212			7.7								57	6.5	58.5	67	166	44.0	184	136	266	
1410	222	8.1	12.8	28.0	4 - 6	921/1013	100.1	30.2	104	32	85	13	60	75	168	51		144	268	4,531
1411			12.3								86	13.8	59.0	69	168	50.0	191	144	268	
1560	298	8.7	16.7	40.0	9 -11	1130/1254	98.8	30.1	104	33	100	19	55	72	169	56		153	270	5,434
1565			16.0								96	19.9	62.5	70	169	55.0	196	153	272	
1560-O	299	8.7	16.7	40.0	8 -11	1121/1236	104.7	30.1	100	33										5,334

RECIPROCAL COURSE

ERPM	SHP (1)	SPEED KTS	FUEL GPH	AIRBX " HG	EXHBK " WTR	AIRFLW CFM	AIR T IN DEG F	AIR P IN " HG	ERT DEGF	ER RH %	LOAD %	TURBO PSI	FUELP PSI	FUELT DEG F	JWT DEGF	LOP PSI	LOT DEGF	GRT DEGF	GRP PSI	PULL LBS
1555-O	294	9.2	16.0	38.5	8 -10	1080/1187	106.8	30.15	101	34										5,598
1560	282	9.3	15.7	36.0	6 - 9	1042/1129	98.9	30.1	103	34	100	18	61	71	169	55		151	270	4,958
1553			14.1								94	18.3	56.0	73	170	56.0	195	151	270	
1410	219	8.5	12.3	26.5	4 - 6	916/1012	99.5	30.2	104	34	85	13	60	71	168	51		156	268	4,602
1408			10.9								86	13.4	60.0	70	168	52.0	192	156	268	
1207	138	7.1	8.1	13.0	2.0	664/ 737	107.1	30.1	105	33	55	6	56	70	165	45		153	268	3,400
1207			8.4								52	5.8	57.0	70	165	45.0	185	152	268	
1003	76	6.0	5.2	4.5	1.5	466/ 517	119.7	30.1	108	32	53	2	57	71	163	34		148	266	2,434
1005			4.4								51	2.0	55.5	70	164	36.0	179	149	266	
750	#	4.6	2.6	1.5	1	268/ 291	121.3	30.1	111	31	44	0	41	70	162	27		143	262	1,224
753			2.8								46	0.4	42.0	70	162	25.0	173	144	264	

600 - NOT PERFORMED ON RECIPROCAL COURSE XXX

TABLE B-8

PORT MAIN ENGINE PARAMETERS TOWING USCGC AQUIDNECK - BOTH COURSES
DISPLACEMENT - 42,785 LBS

xxxx - INITIAL COURSE yyyy - RECIPROCAL COURSE

ERPM	SHP (1)	SPEED KTS	FUEL GPH	AIRBX " HG	EXHBK " WTR	AIRFLW CFM	AIR T IN DEG F	AIR P IN " HG	ERT DEGF	ER RH %	LOAD %	TURBO PSI	FUELP PSI	FUELT DEG F	JWT DEGF	LOP PSI	LOT DEGF	GRT DEGF	GRP PSI	PULL LBS
604	11	2.8	1.9	0.7	0.5		109.6	30.1	104	34	38	0	29	67	162	19		123	262	912
601			2.2								40	0.1	28.0	67	162	19.0	169	123	262	
600 - NOT PERFORMED ON RECIPROCAL COURSE																				XXX
749	#	3.5	2.8	1.0	0.9		110.7	30.1	105	34	50	0	42	67	164	26		125	262	1,321
753			3.1								48	0.5	42.0	67	164	25.0	173	125	262	
750	#	4.6	2.6	1.5	1	268/ 291	121.3	30.1	111	31	44	0	41	70	162	27		143	262	1,224
753			2.8								46	0.4	42.0	70	162	25.0	173	144	264	
1008	76	5.1	5.2	5.0	1.5		110.1	30.1	107	32	53	2	57	67	165	37		128	266	2,398
1014			5.0								53	2.1	57.0	67	165	38.0	179	128	264	
1003	76	6.0	5.2	4.5	1.5	466/ 517	119.7	30.1	108	32	53	2	57	71	163	34		148	266	2,434
1005			4.4								51	2.0	55.5	70	164	36.0	179	149	266	
1207	135	6.6	8.4	13.4	2.0		104.8	30.1	106	32	56	6	59	72	166	45		136	266	3,200
1212			7.7								57	6.5	58.5	67	166	44.0	184	136	266	
1209	138	7.1	8.1	13.0	2.0	664/ 737	107.1	30.1	105	33	55	6	56	70	165	45		153	268	3,400
1207			8.4								52	5.8	57.0	70	165	45.0	185	152	268	
1410	222	8.1	12.8	28.0	4 - 6	921/1013	100.1	30.2	104	32	85	13	60	75	168	51		144	268	4,531
1411			12.3								86	13.8	59.0	69	168	50.0	191	144	268	
1410	219	8.5	12.3	26.5	4 - 6	916/1012	99.5	30.2	104	34	85	13	60	71	168	51		156	268	4,602
1408			10.9								86	13.4	60.0	70	168	52.0	192	156	268	
1560	298	8.7	16.7	40.0	9 -11	1130/1254	98.8	30.1	104	33	100	19	55	72	169	56		153	270	5,434
1565			16.0								96	19.9	62.5	70	169	55.0	196	153	272	
1560	282	9.3	15.7	36.0	6 - 9	1042/1129	98.9	30.1	103	34	100	18	61	71	169	55		151	270	4,958
1553			14.1								94	18.3	56.0	73	170	56.0	195	151	270	
1560-O	299	8.7	16.7	40.0	8 -11	1121/1236	104.7	30.1	100	33										5,334
1555-O	294	9.2	16.0	38.5	8 -10	1080/1187	106.8	30.15	101	34										5,598

TABLE B-9

MAIN ENGINE PARAMETERS BOLLARD PULL

PORT ERPM	STBD ERPM	P SHP	S SHP	PORT LOAD %	STBD LOAD %	PORT TURBO PSI	STBD TURBO PSI	PORT FUELP PSI	STBD FUELP PSI	PORT JW T DEGF	STBD JW T DEGF	P LOP PSI	S LOP PSI	P LOT DEGF	S LOT DEGF	PORT GR T DEGF	STBD GR T DEGF	P GRP PSI	S GRP PSI	LOAD LBS
RUN NO 1																				
750	751	37	44	61	54	0.6	0.4	39.5	43.5	161	164	26.0	25.0	168	168	124	135	264	254	2,760
	869	63	68		73		1.1		46.5		165		30.0		172		126		254	3,600
1007	1008	107	111	73	68	3.9	3.3	48.0	48.0	162	166	36.0	35.0	173	176	127	129	266	256	5,040
1102	1103	143	146	72	66	7.3	5.6	49.0	48.0	163	166	39.0	40.0	177	177	129	130	266	256	5,900
1210	1211	196	184	81	73	11.6	9.6	48.5	48.5	163	167	44.0	45.0	179	181	131	134	268	258	6,900
1304	1302	234	236	94	93	15.4	14.0	50.0	50.0	165	167	46.0	47.0	183	183	134	136	268	258	7,840
1330	1355	252	261	100	100	17.3	16.4	48.5	48.0	168	169	45.0	47.0	191	189	149	143	268	260	8,160
1345	1362			100	100	17.3	16.6	53.5	49.0	168	170	45.0	47.0	191	189	151	144	268	258	-----
1343	1344			100	100	17.1	16.4	48.5	50.0	168	170	47.0	46.0	192	191	154	146	268	258	-----

RUN NO 2

PORT ERPM	STBD ERPM	P SHP	S SHP	PORT LOAD %	STBD LOAD %	PORT TURBO PSI	STBD TURBO PSI	PORT FUELP PSI	STBD FUELP PSI	PORT JW T DEGF	STBD JW T DEGF	P LOP PSI	S LOP PSI	P LOT DEGF	S LOT DEGF	PORT GR T DEGF	STBD GR T DEGF	P GRP PSI	S GRP PSI	LOAD LBS
750	750	39	41																	2,720/2,780
862	862	63	68	78	71	1.3	1.1	46.5	46.5	165	169	30.0	28.0	176	179	158	141	264	250	3,700/3,640
999	999	104	107	72	69	3.6	3.1	50.0	48.5	165	168	36.0	35.0	179	180	161	140	268	256	4,960/5,000
1102	1104	145	141	73	68	6.9	6.0	49.5	49.5	165	168	40.0	38.0	181	183	163	139	266	262	5.900/5,960
1209	1209	186	192	80	75	11.3	9.5	49.5	50.5	166	169	42.0	43.0	185	184	168	139	266	266	7,020/7,000
1309	1307	240	234	96	92	15.6	14.0	52.0	50.0	167	169	45.0	46.0	187	188	172	140	266	268	7,800/8,000
1318	1365	252	262	100	100	16.5	16.3	50.5	49.5	168	170	45.0	48.0	189	189	176	141	266	264	8,200
547	549	17	9	41	35	0.1	0.0	23.0	24.5	165	170	15.0	14.0	176	177	189	142	256	252	/1,400

TABLE B-10

MAIN ENGINE PARAMETERS BOLLARD PULL - BOTH RUNS

xxxx - RUN 1 yyyy - RUN 2

PORT ERPM	STBD ERPM	P SHP	S SHP	PORT LOAD %	STBD LOAD %	PORT TURBO PSI	STBD TURBO PSI	PORT FUELP PSI	STBD FUELP PSI	PORT JW T DEGF	STBD JW T DEGF	P LOP PSI	S LOP PSI	P LOT DEGF	S LOT DEGF	PORT GR T DEGF	STBD GR T DEGF	P GRP PSI	S GRP PSI	LOAD LBS
547	549	17	9	41	35	0.1	0.0	23.0	24.5	165	170	15.0	14.0	176	177	189	142	256	252	/1,400
750	751	37	44	61	54	0.6	0.4	39.5	43.5	161	164	26.0	25.0	168	168	124	125	264	254	2,750
750	750	39	41																	2,720/2,780
	869	63	68		73		1.1		46.5		165		30.0		172		126		254	3,600
862	862	63	68	78	71	1.3	1.1	46.5	46.5	165	169	30.0	28.0	176	179	158	141	264	250	3,700/3,640
1007	1008	107	111	73	68	3.9	3.3	48.0	48.0	162	166	36.0	35.0	173	176	127	129	266	256	5,040
999	999	104	107	72	69	3.6	3.1	50.0	48.5	165	168	36.0	35.0	179	180	161	140	268	256	4,960/5,000
1102	1103	143	146	72	66	7.3	5.6	49.0	48.0	163	166	39.0	40.0	177	177	129	130	266	256	5,900
1102	1104	145	141	73	68	6.9	6.0	49.5	49.5	165	168	40.0	38.0	181	183	163	139	266	262	5.900/5,960
1210	1211	196	184	81	73	11.6	9.6	48.5	48.5	163	167	44.0	45.0	179	181	131	134	268	258	6,900
1209	1209	186	192	80	75	11.3	9.5	49.5	50.5	166	169	42.0	43.0	185	184	168	139	266	266	7,020/7,000
1304	1302	234	236	94	93	15.4	14.0	50.0	50.0	165	167	46.0	47.0	183	183	134	136	268	258	7,840
1309	1307	240	234	96	92	15.6	14.0	52.0	50.0	167	169	45.0	46.0	187	188	172	140	266	268	7,800/8,000
1330	1355	252	261	100	100	17.3	16.4	48.5	48.0	168	169	45.0	47.0	191	189	149	143	268	260	8,160
1345	1362			100	100	17.3	16.6	53.5	49.0	168	170	45.0	47.0	191	189	151	144	268	258	-----
1343	1344			100	100	17.1	16.4	48.5	50.0	168	170	47.0	46.0	192	191	154	146	268	258	-----
1318	1365	252	262	100	100	16.5	16.3	50.5	49.5	168	170	45.0	48.0	189	189	176	141	266	264	8,200

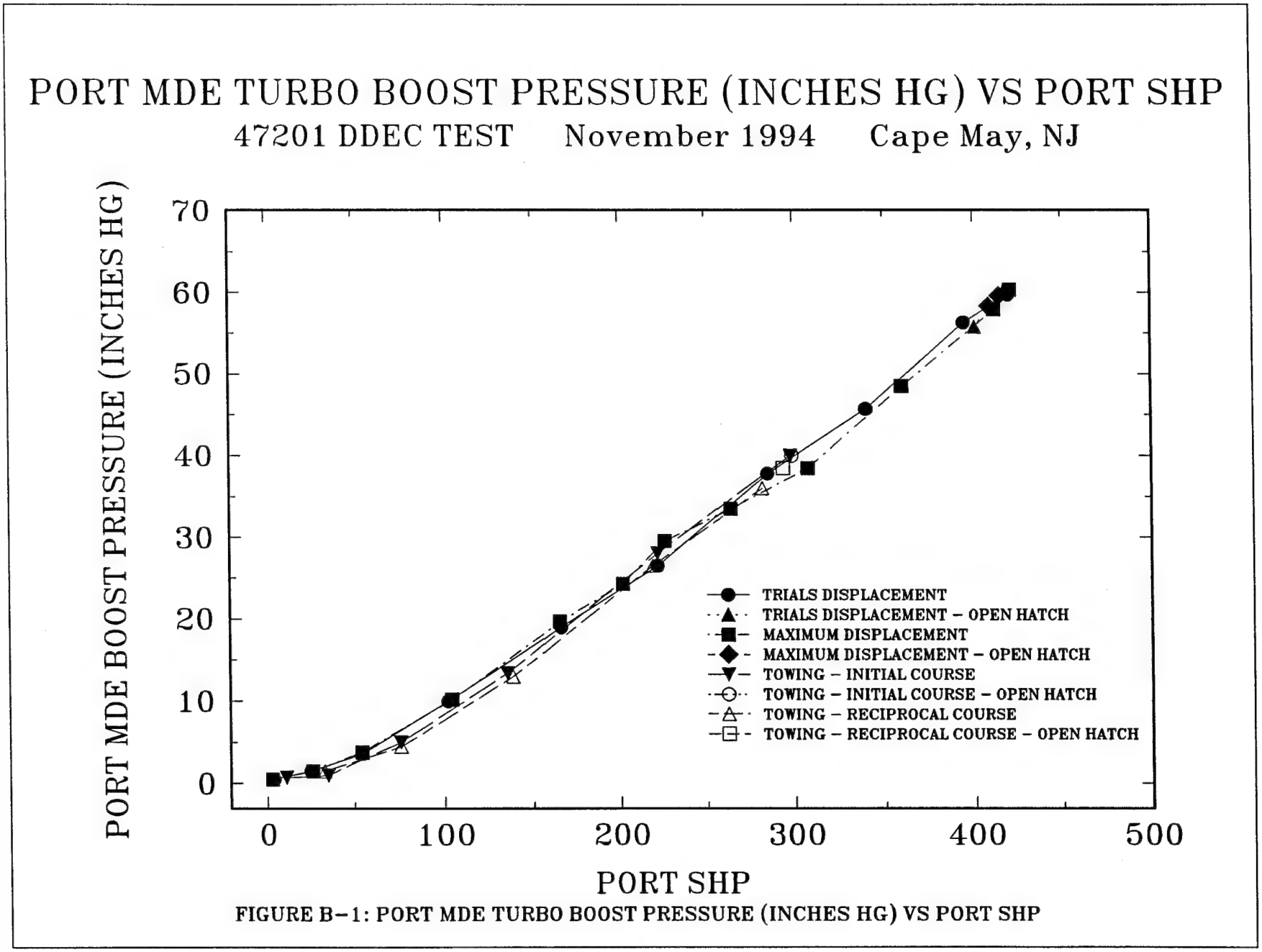

FIGURE B–1: PORT MDE TURBO BOOST PRESSURE (INCHES HG) VS PORT SHP

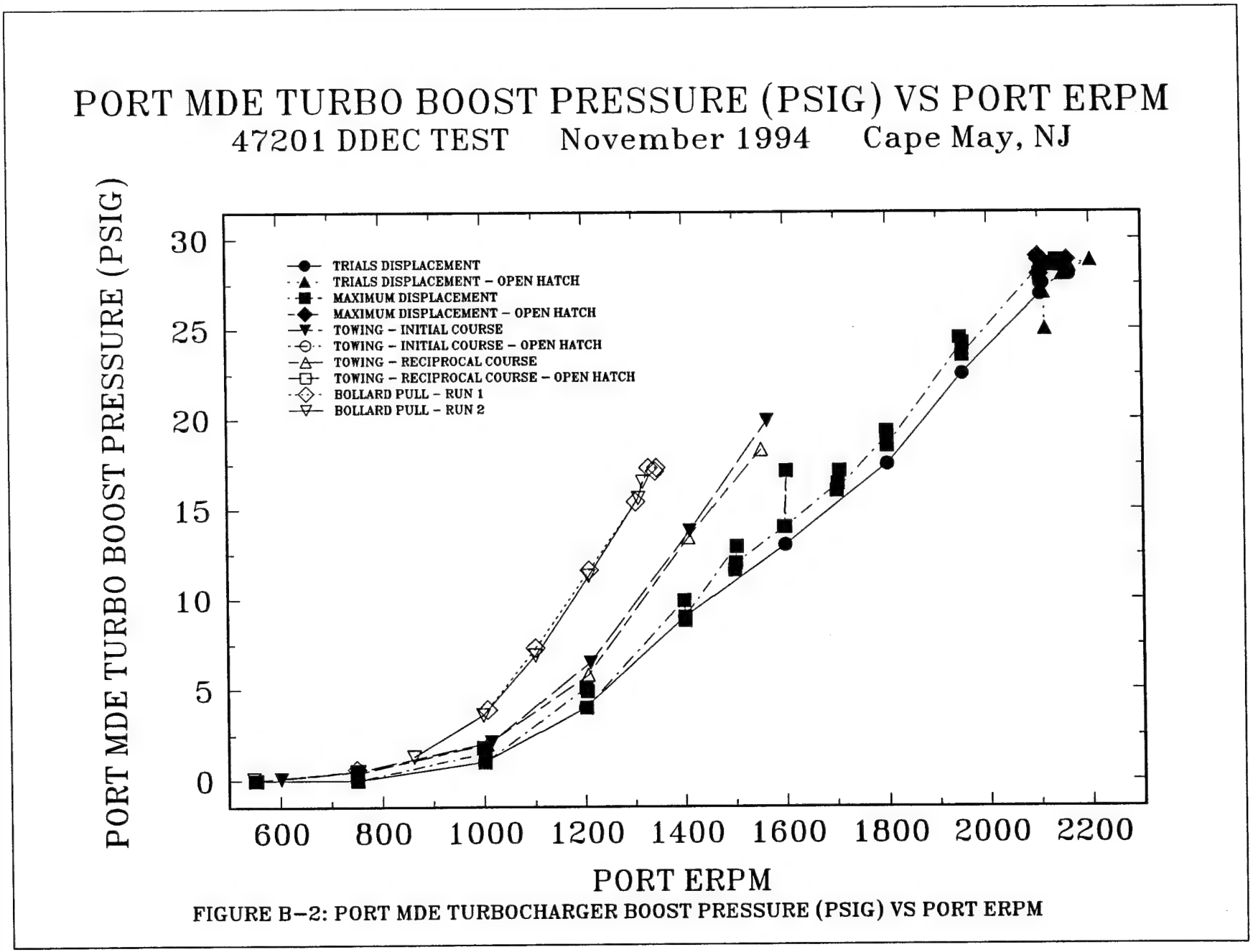

FIGURE B–2: PORT MDE TURBOCHARGER BOOST PRESSURE (PSIG) VS PORT ERPM

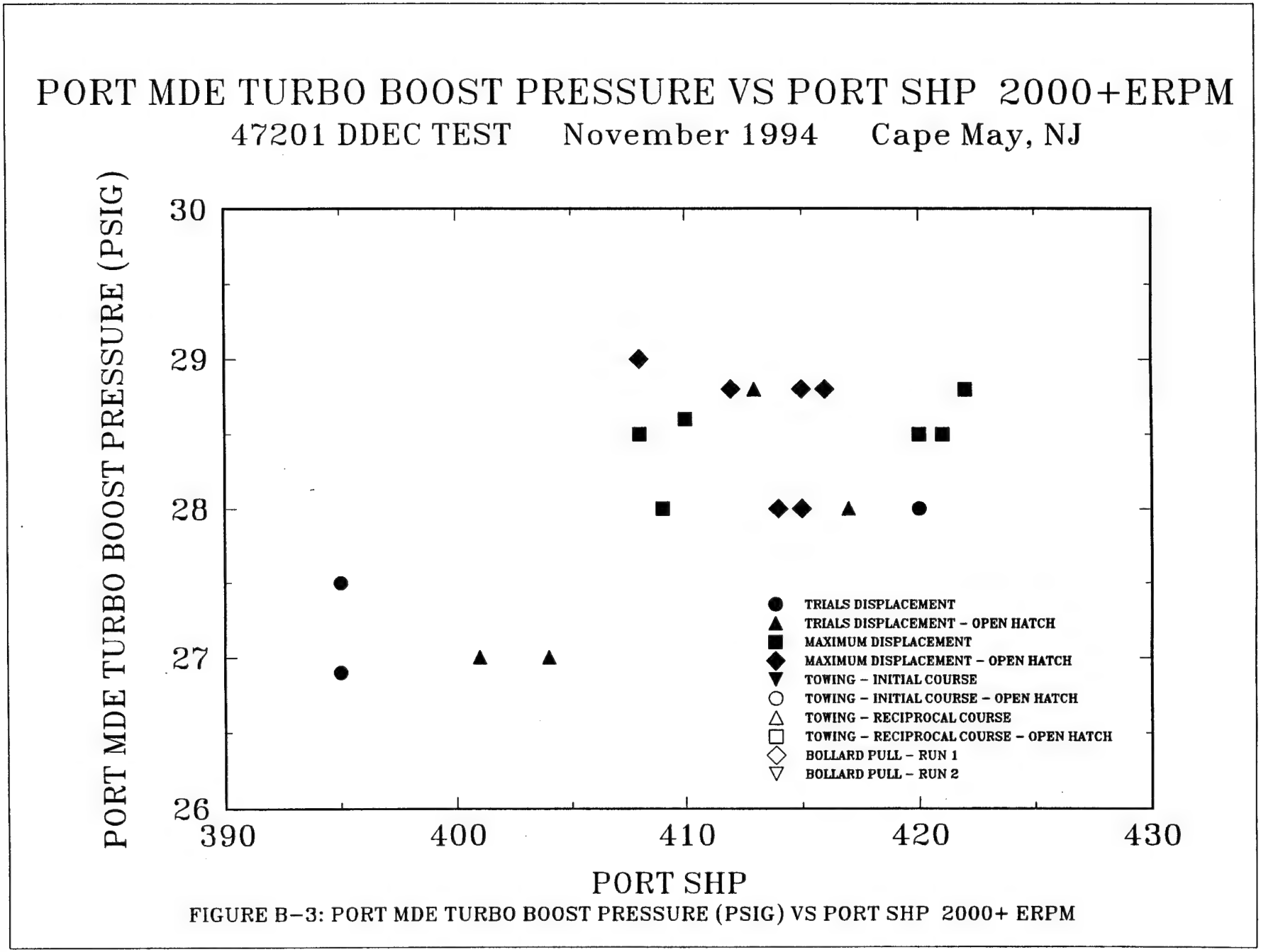

FIGURE B–3: PORT MDE TURBO BOOST PRESSURE (PSIG) VS PORT SHP 2000+ ERPM

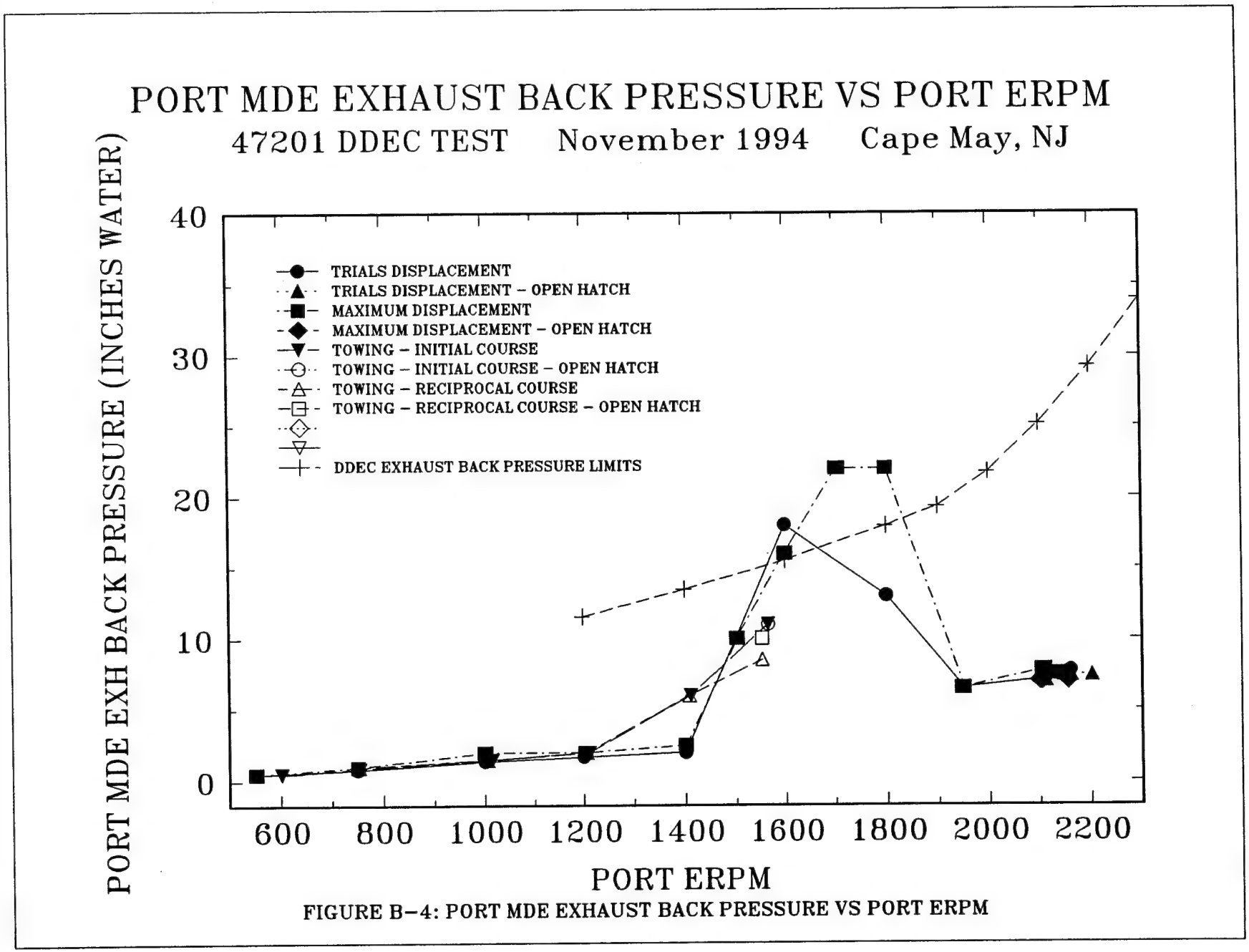

FIGURE B–4: PORT MDE EXHAUST BACK PRESSURE VS PORT ERPM

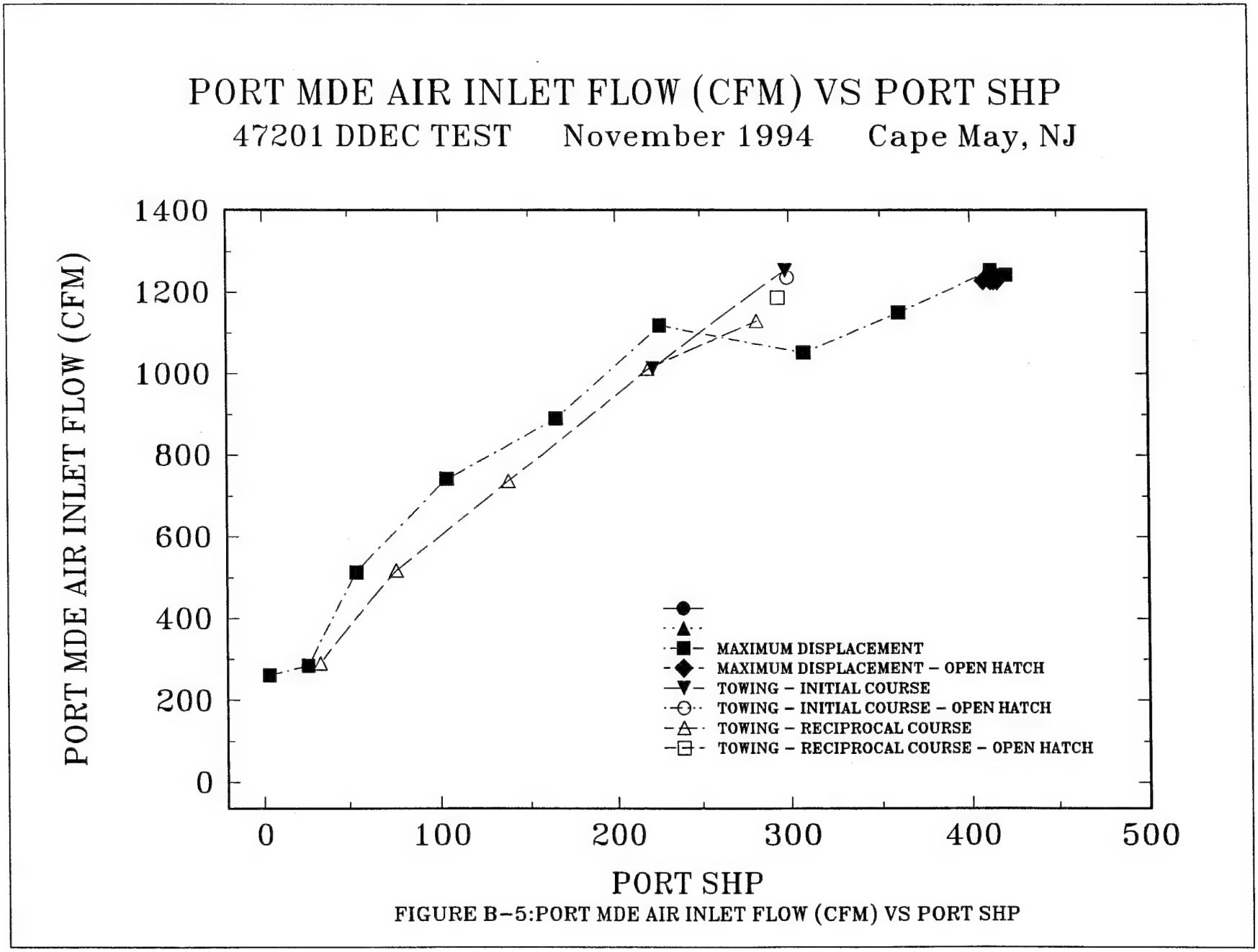

FIGURE B–5:PORT MDE AIR INLET FLOW (CFM) VS PORT SHP

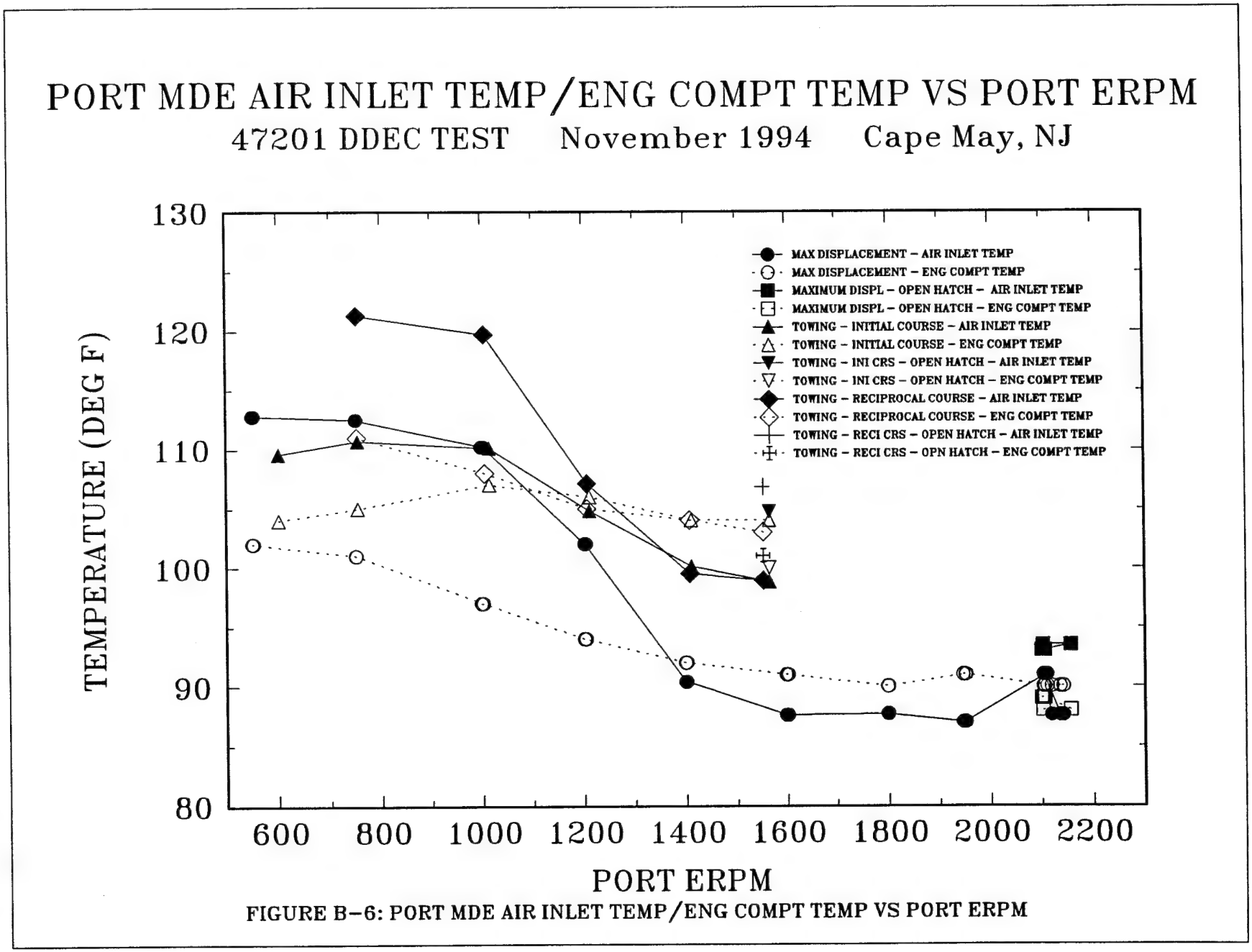

FIGURE B–6: PORT MDE AIR INLET TEMP/ENG COMPT TEMP VS PORT ERPM

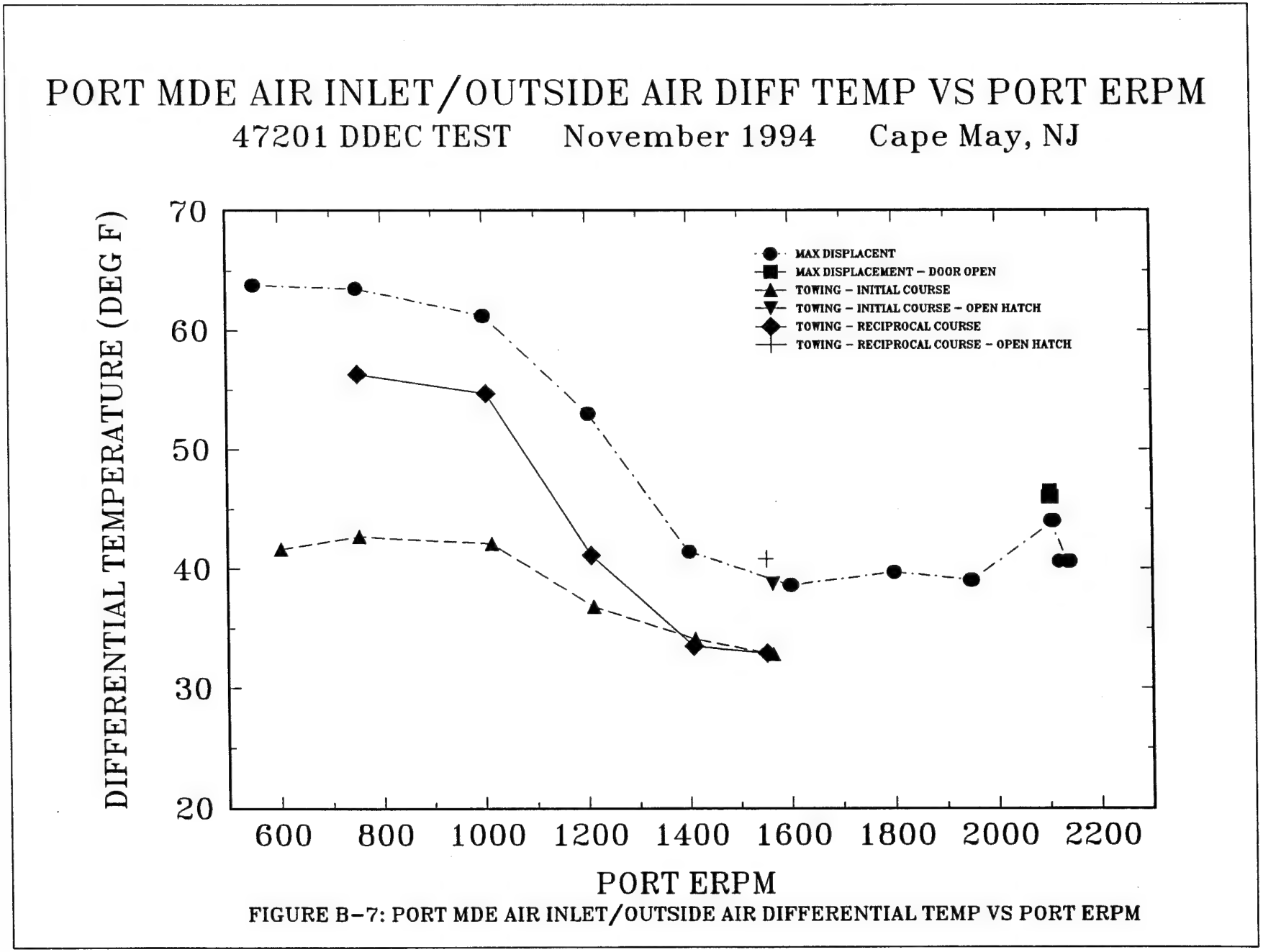

FIGURE B–7: PORT MDE AIR INLET/OUTSIDE AIR DIFFERENTIAL TEMP VS PORT ERPM

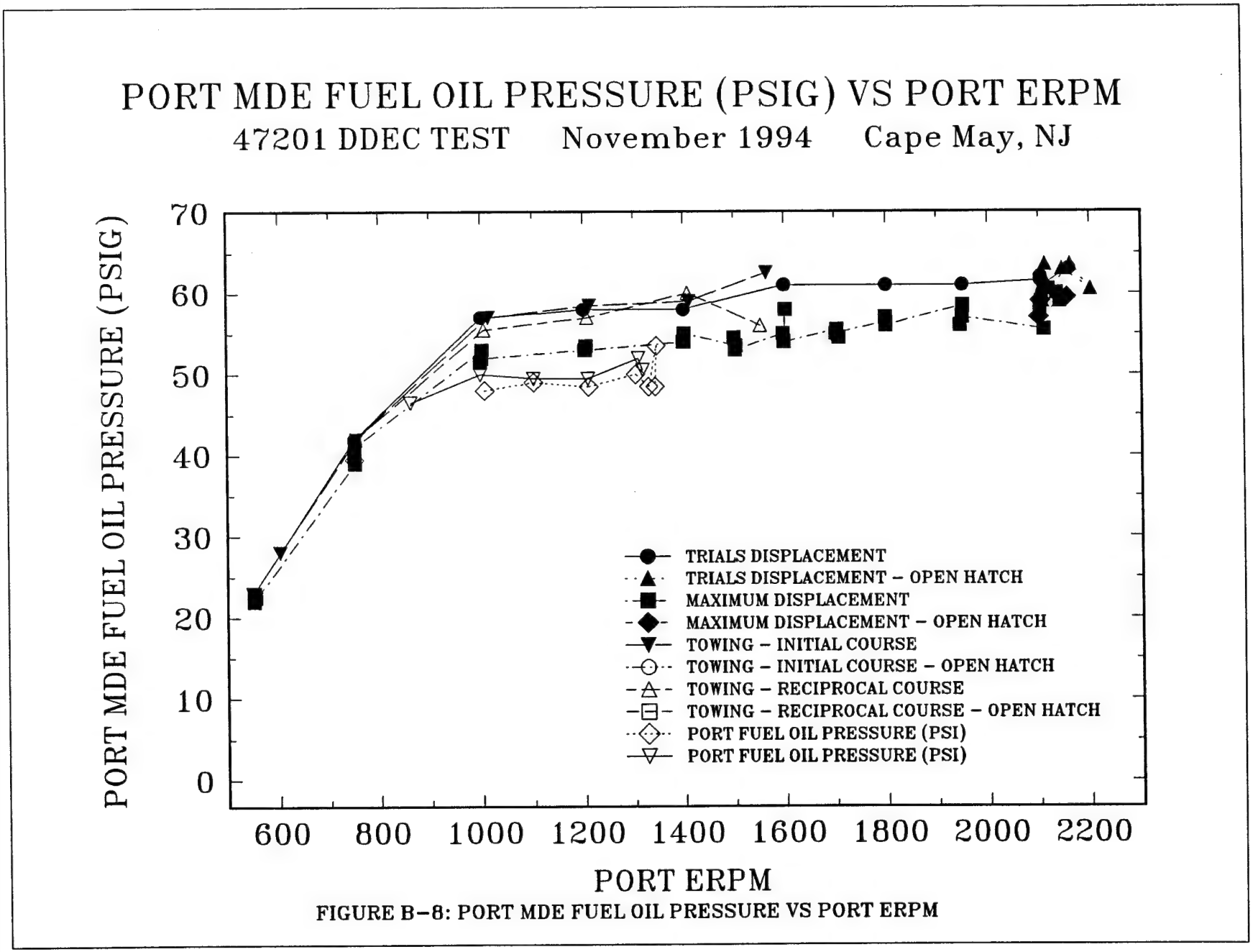

FIGURE B–8: PORT MDE FUEL OIL PRESSURE VS PORT ERPM

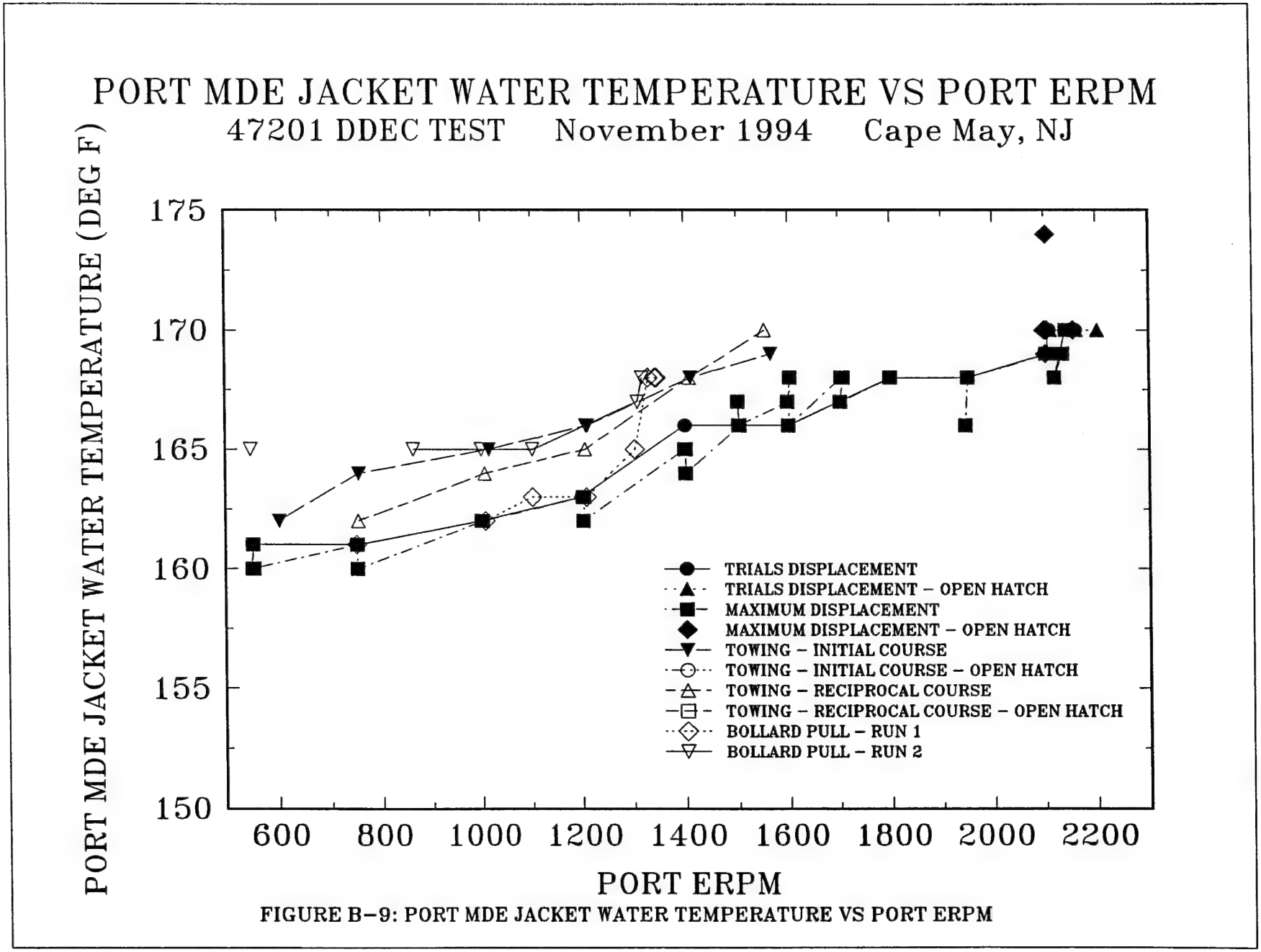

FIGURE B–9: PORT MDE JACKET WATER TEMPERATURE VS PORT ERPM

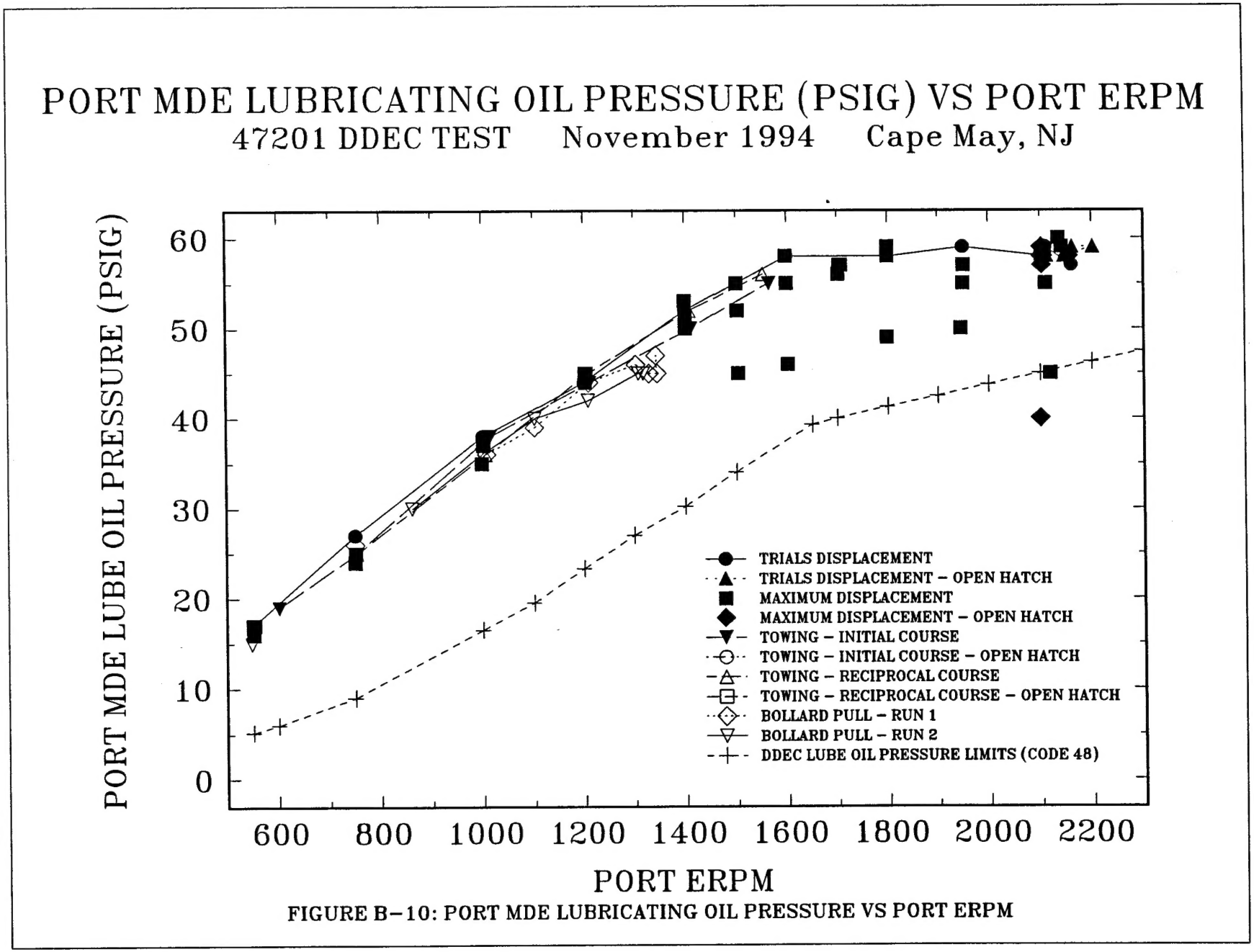

FIGURE B–10: PORT MDE LUBRICATING OIL PRESSURE VS PORT ERPM

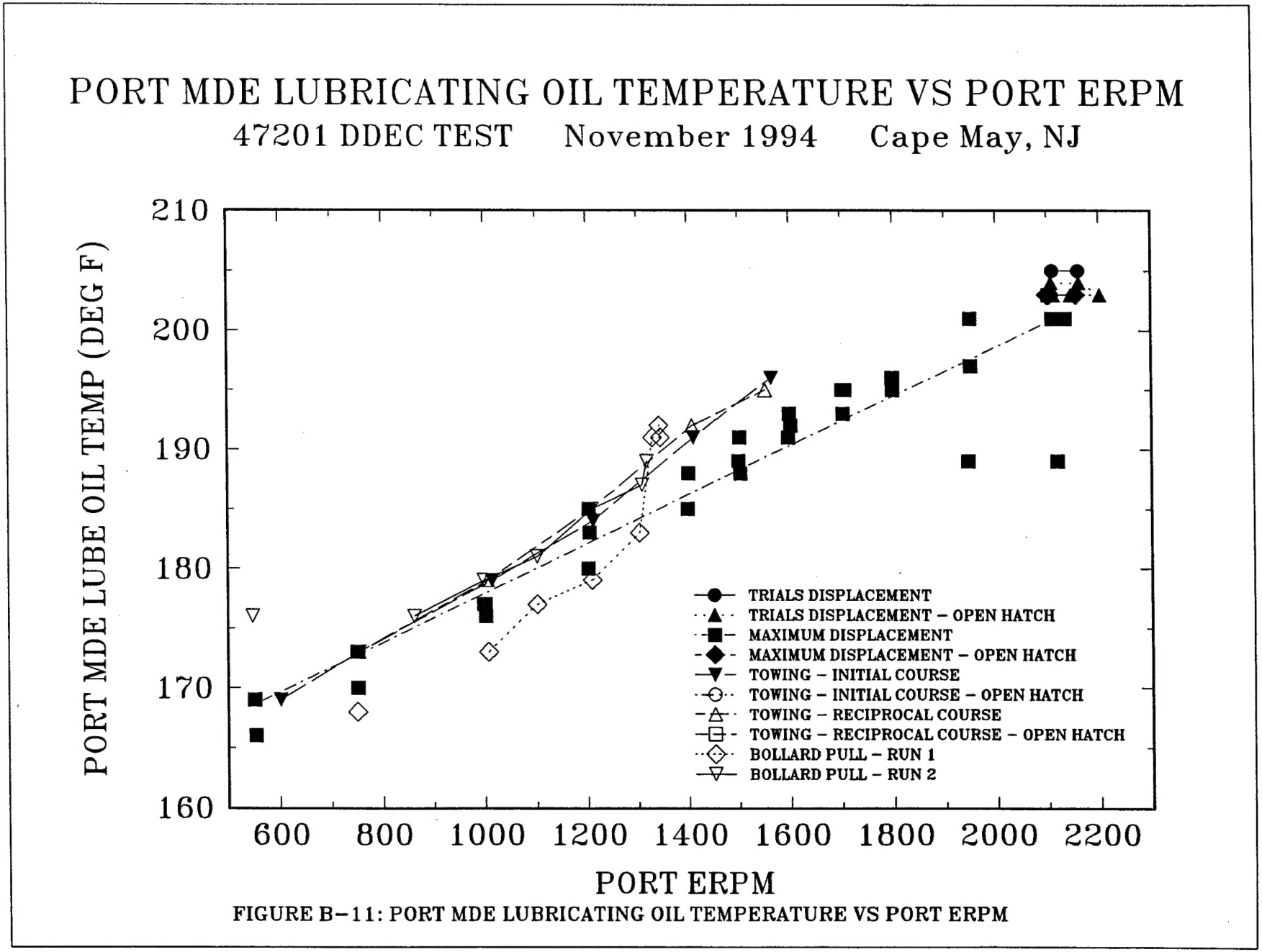

FIGURE B–11: PORT MDE LUBRICATING OIL TEMPERATURE VS PORT ERPM

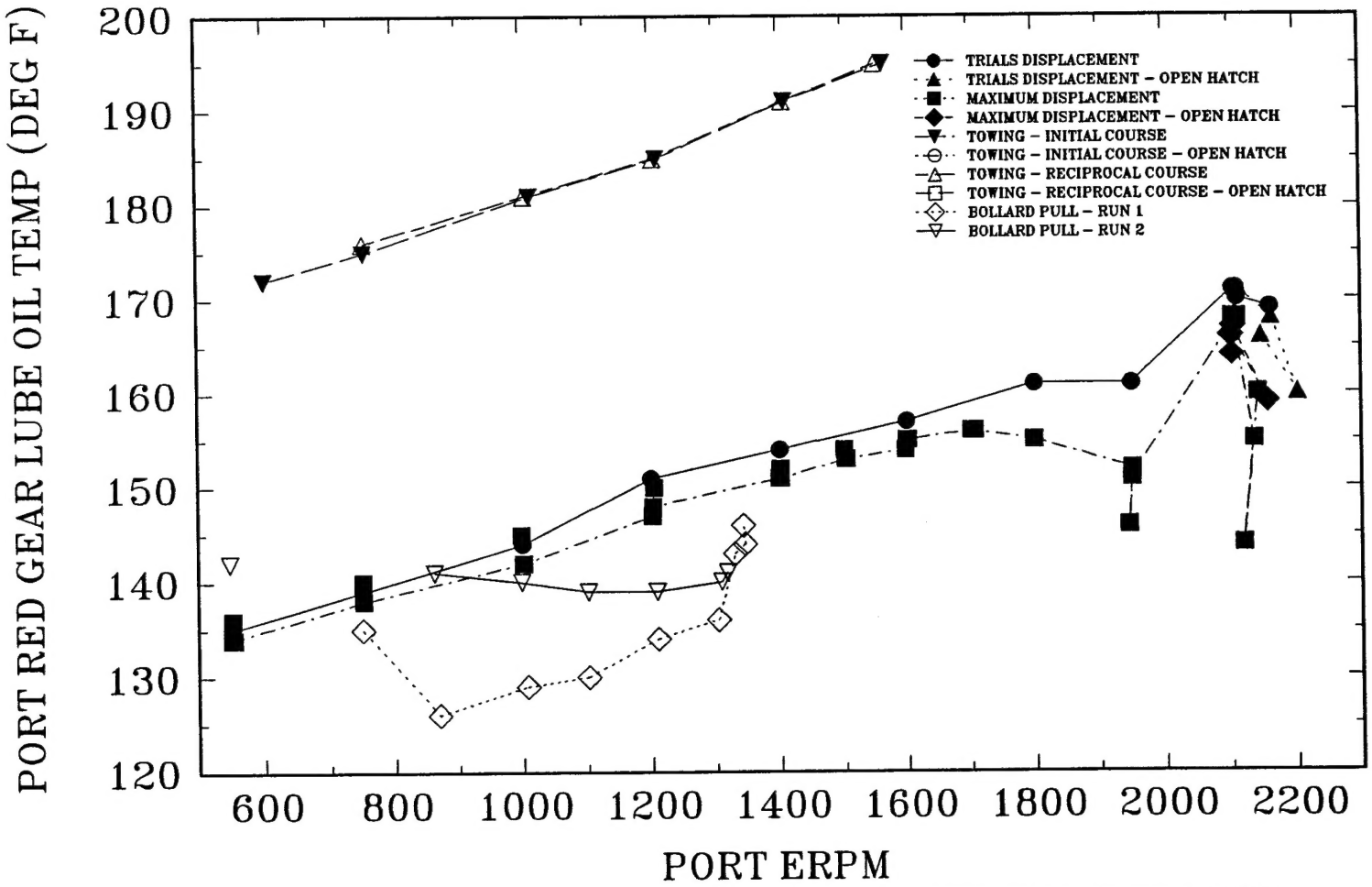

FIGURE B–12: REDUCTION GEAR LUBRICATING OIL TEMPERATURE VS PORT ERPM

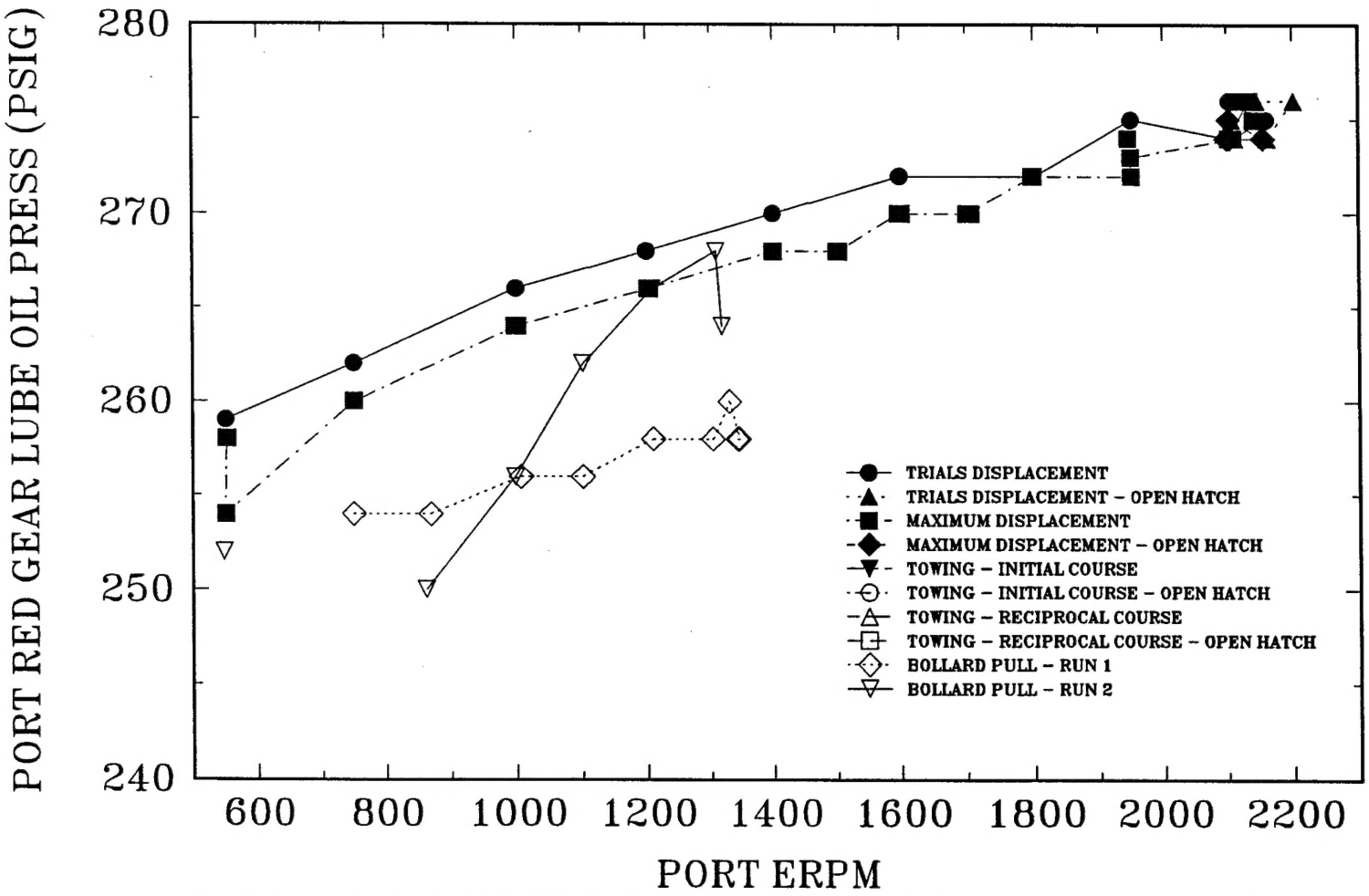

FIGURE B–13: PORT REDUCTION GEAR LUBRICATING OIL PRESSURE VS PORT ERPM